Vol. 106
No. 2764

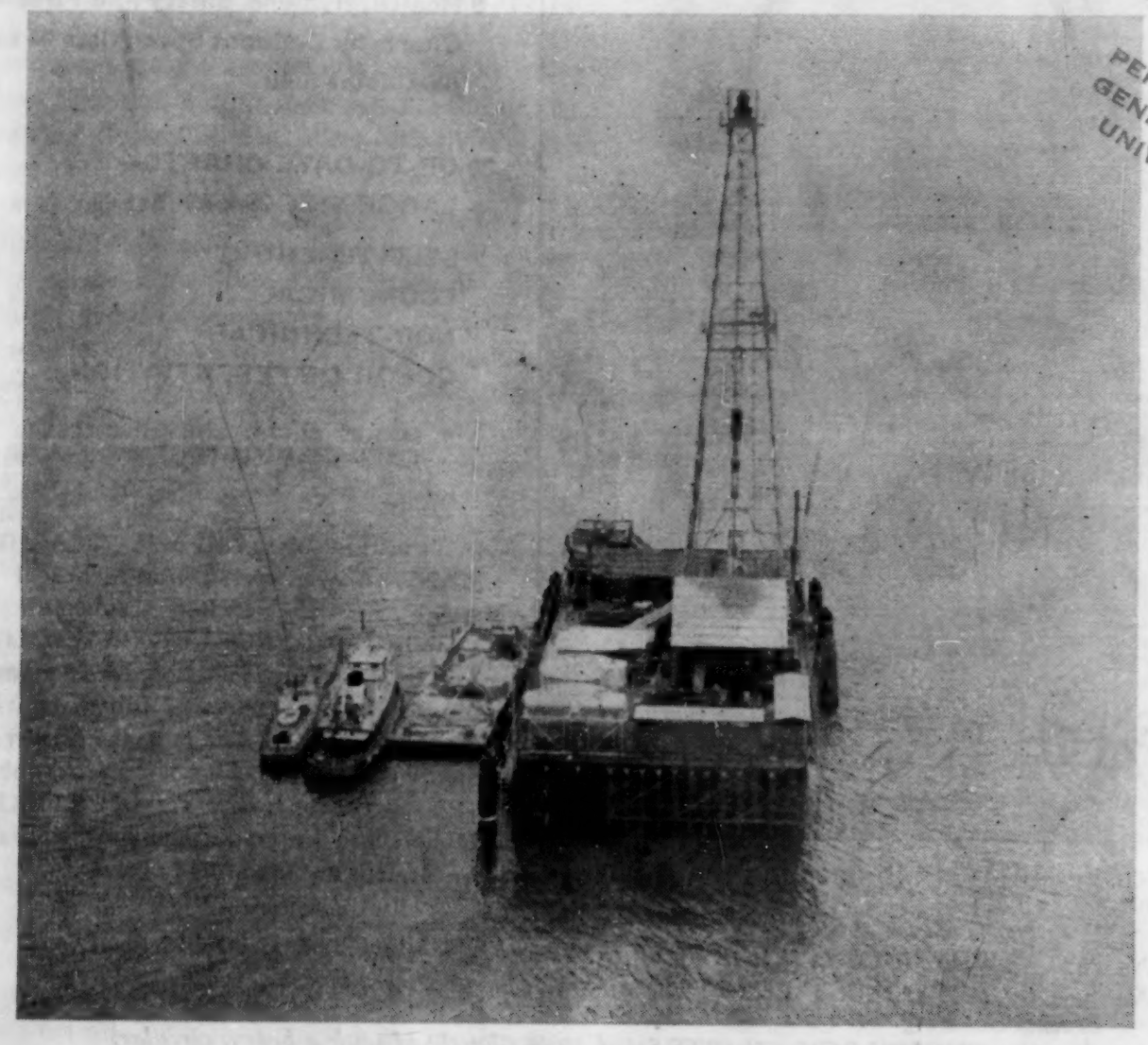
DEC 30

Pages 603-624

December 19, 1947

Science

THE SCIENTISTS NEWSWEEKLY



An example of off-shore drilling in the Gulf of Mexico. Shown above is Magnolia Petroleum Company's well #1, located 5 miles off-shore from Eugene Island, off the coast of St. Mary's Parish, Louisiana. This well was recently completed as a dry hole at TD 12,874 feet.

Published by the
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Petroleum—Today and Tomorrow

Kirtley F. Mather

Petroleum—Today and Tomorrow

Kirtley F. Mather
Professor of Geology, Harvard University

FROM ALMOST EVERY POINT OF VIEW, petroleum was "strategic mineral number one" during the World War that ended in 1945. Even the spectacular advent of the atomic bomb in the final days of the conflict did not displace it from its position of prime importance, although within a few years uranium will almost certainly be the "number one" material in the minds of military strategists, if it is not even now in that position.

It was the ceaseless flow of petroleum from the oil fields of the United States, Venezuela, the Middle East, and a few other places of lesser importance that kept the Allied Forces in motion on land and sea and in the air, the world around, and even provided them with some of the most potent of their weapons. It was the progressive attrition of Germany's supplies of oil that clipped the wings of the Luftwaffe and made possible the astonishingly swift advance of the Allied Forces from the periphery of Hitler's ill-gotten empire to its nerve center in Berlin. It was the cutting of the supply lines from the oil fields of the East Indies to Japan and the exhaustion or destruction of the Japanese stores of petroleum that presaged the capitulation of the Japanese war lords, even before the bombs fell on Hiroshima and Nagasaki. Verily, the Allied Powers rode to victory on a flood of oil.

Now that the "shooting war" is ended, and as we turn to the distressingly difficult task of arranging a peaceful world in which men may use the rich resources of our bountiful earth for the welfare of all mankind, petroleum continues to hold its leadership among the natural resources of the earth. Both as fuel and as raw material for chemical industries, petroleum will hold the center of the stage for many years to come. Hardly any other substance illustrates so fully the manner in which science and technology may be combined to achieve the utmost success in contributing to human efficiency and comfort.

Fundamental to any understanding of the problems implied by my topic is the comprehension of the fact that petroleum is a nonrenewable resource; it is in the category of nature's stored capital, not of man's annual income. It is, of course, true that the geologic processes responsible for oil pools are continuing to operate today as in the past. On the sea floor off the coast of southern California, for example, there are broad hollows where the tissues of marine animals and plants are now accumulating in mud and ooze at depths of 200 or 300 fathoms. The conditions are closely similar to those that recurred repeatedly during the Paleozoic era in Oklahoma and Texas, when the oil of certain rich oil fields was being generated. But millions of years must elapse before that organic material can be transformed into petroleum, stored in the interstices of overlying sandstones, and made available by crustal movements for recovery from wells to be drilled by some future inhabitants of the earth's surface.

In relation to the feverish haste of mankind's insatiable demands, the creative processes of nature's laboratory operate very slowly. For all practical purposes our planet must be reckoned as a storehouse of such minerals as petroleum, not as a factory in which that substance is generated year by year, or even millenium by millenium. Mother Earth has made available a cupboard richly stocked with a vast amount and a great variety of goods indispensable to us in an age of science and technology, and among these stores we find petroleum. Each year we go to the shelves of that cupboard and take away a few packages of the goods stored thereon; if we keep going long enough, some day someone will find that the cupboard is bare. Indeed, petroleum is now being used at such a rate in relation to its total amount in the earth's crust that its complete exhaustion is, from a geological viewpoint, alarmingly imminent.

Between 1859, when the first oil well was drilled in the United States, and January 1, 1947, the production of petroleum from all parts of the world has totaled nearly 52,000,000,000 barrels. Of that total, slightly more than 30,000,000,000 barrels were produced in the United States. As shown in Fig. 1, the annual production, both for the world as a whole and for the United States, has increased each year since 1938, with the sole exception of 1942, the first year of American participation in the war, and there is every indication that these increases will continue for the next few years. Indeed, it is a conservative estimate that the world's oil production will average

"Petroleum—Today and Tomorrow" was presented as an illustrated lecture before the British Association for the Advancement of Science on August 29, 1947, during the Association's meetings held in Dundee, Scotland. Dr. Mather's discourse was presented as another in the series of exchange lectures established in 1938 by the BAAS and the AAAS and is published in *Science* by arrangement with the Officers of the British Association.

more than 3,000,000,000 barrels per year during the decade 1947–56.

Such figures begin to take on real significance when we note that the most recent estimates made by competent

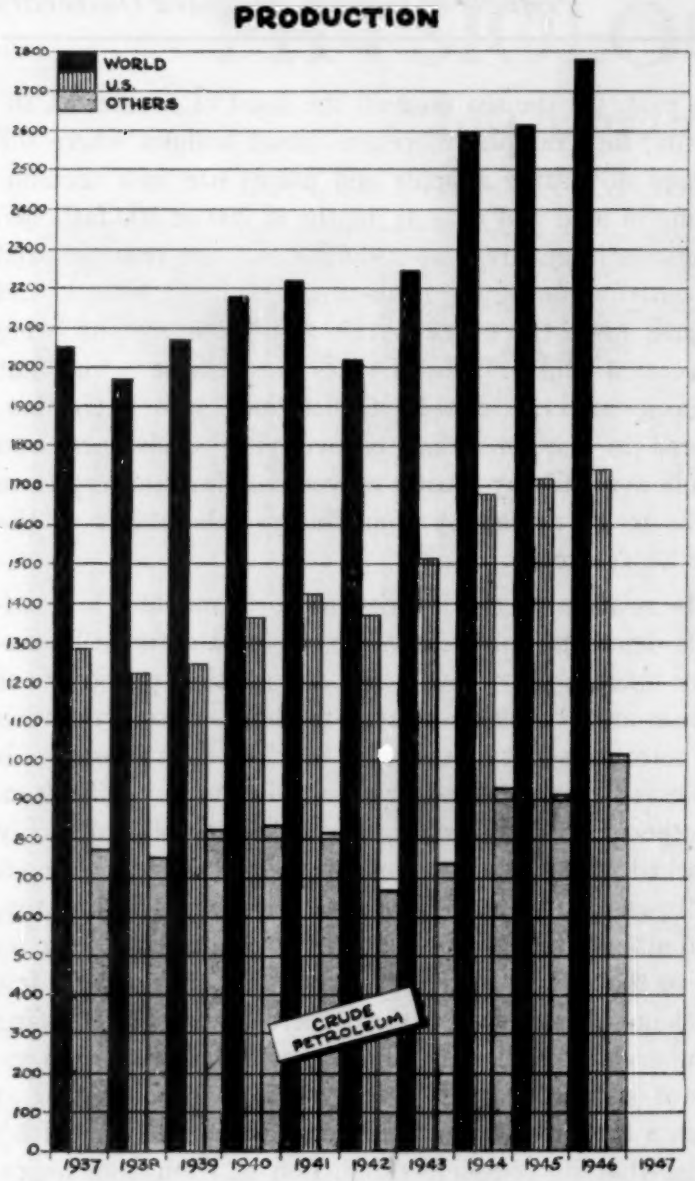


FIG. 1. Annual production of petroleum, 1937–46, in millions of barrels.

petroleum geologists (see Fig. 2) give a figure slightly less than 70,000,000,000 barrels (68,924,000,000) for the proved reserves of petroleum throughout the world on January 1, 1947. It would, however, be far too simple and quite erroneous to make the easy arithmetical calculation and announce that the world's oil will be exhausted in 23 years. The proved reserves are only a fraction of the actual reserves. Whether the fraction is one-half or one-tenth is a matter of great moment, requiring careful consideration.

The particular combination of specifically defined geological conditions requisite for an oil accumulation of economic value is now well known to petroleum geologists. Every oil field fulfills the specifications in one way or another, and the failure to find oil in an exploratory borehole can almost always be explained by an observable lack of one or more of the requisite geological conditions.

The first requirement is an adequate source of supply of the organic materials from which petroleum may be formed by natural processes of a biochemical and ge chemical character. Source beds are sedimentary rock most commonly shale, but in some instances limeston or sandstone, in which the tissues of plants or anima were buried, before they were completely oxidized, whi the sediments were accumulating on a sea floor, lak bottom, or stream bed. Certainly, almost all, and ver probably all adequate source beds are of marine origi

In the second place there must be a suitable reservo rock in fairly close proximity to the source beds. Rese voir rocks must be both porous and permeable, in orde to provide space for the oil in the interstitial voids and t permit its movement, first from the source beds into it interstices and later from them into a borehole. The bes

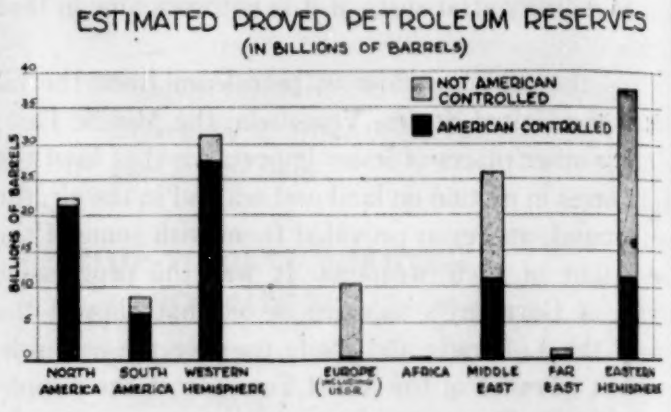


FIG. 2. Proved reserves of petroleum as of January 1, 1947.

reservoir rocks are sandstones and limestones with a porosity of 5–25 per cent of their volume and with per meability ranging from 100 or 200 to 1,000 or 2,000 millidarcies. It is not essential that a reservoir rock be marine in origin; lacustrine, fluviatile, or eolian sandstones will do just as well. In fact, a volcanic ash deposit, a tuff or agglomerate, might be quite satisfactory.

Thirdly, there must be some sort of trap to prevent the upward migration of the oil as it seeks to ascend to the surface because of its lesser density than that of water. The trap may be (1) "structural," produced by folding or faulting of the rocks or a combination of the two, or by the intrusion of salt or igneous rock into the sedimentary series, or (2) "stratigraphic," resulting from the pinching out of the reservoir rock updip or from excessive lateral reduction in porosity or permeability within the reservoir bed, or formed by the unconformable deposition of relatively impermeable beds across the eroded edges of tilted strata that include a reservoir rock.

Finally, the sedimentary system containing source beds and reservoir rocks must not have been unduly metamorphosed, either as a result of deep burial, horizontal compression during mountain-making movements, or igneous intrusions on a large scale. Moderate pressures stimulate geochemical changes conducive to the evolution of petroleum from its source materials, but excessive pressure destroys petroleum. Gentle folds are desirable to provide structural traps and to tilt reservoir rocks so that the oil can move upward into stratigraphic traps, but closely compressed folds do not yield oil. The greatest

depth from which oil has thus far been produced is slightly greater than 13,000 feet, although several holes have been drilled deeper than 15,000 feet and at least one exceeds 17,000 feet. It is extremely unlikely that oil will ever be produced anywhere from depths greater than 20,000 feet, for the pressures and temperatures are too great to permit petroleum to exist in the fluid state.

Although geological and geophysical surveys at the earth's surface permit the discovery of places beneath which one or more of these four requisites for an oil field are known to be met, no one can guarantee in advance of drilling that oil will be encountered at depth. Satisfactory criteria for the identification of source beds as such are not yet known. Sedimentary rocks are notorious for their facility to change in textural, lithologic, and mineralogic characteristics when traced laterally from place to place. There was no reason, for example, to expect in advance of drilling that the structural trap a few miles south of Lincoln, in Nottinghamshire, would be devoid of oil, whereas the very similar structure in similar rocks at Eakring, only 25 miles distant, would yield very considerable production. Not until the drill has yielded information concerning the texture and thickness of potential reservoir rocks within the favorable structure itself and has demonstrated the actual presence of petroleum can one egin to calculate the quantity of proved reserves for any oil field.

The relation between proved reserves and the total supply of petroleum in the ground is est indicated by the history of American 'oil fields. Almost every minor variant of the geological conditions essential for an oil pool is found somewhere within the extensive petroliferous area of the United States. Accurate records of nearly all drilling operations and of the resulting production of oil and gas are available over a long period of years. American geologists have specialized in the computation of known and probable reserves for each of the many oil fields at various stages in their development, from the drilling of the "discovery well" to the exhaustion and abandonment of the older fields.

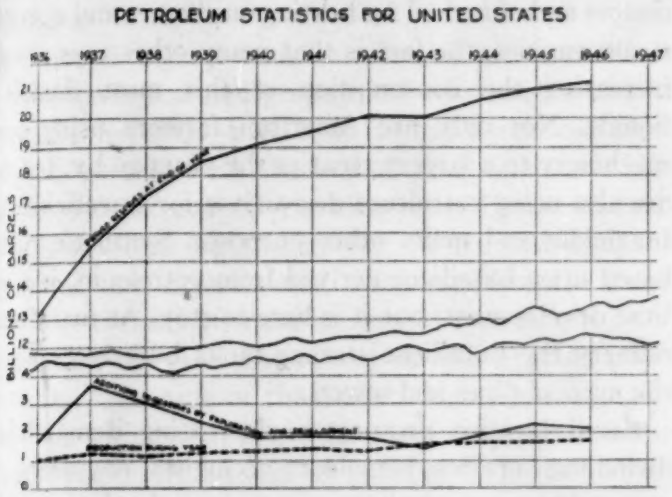


FIG. 3. Relation of petroleum production to proved reserves, United States, 1936–46.

The broad picture is indicated in Fig. 3. During the 11 years from 1936 to 1946, inclusive, there has been an intensive search for new oil fields, the results of which have made possible the increase in annual production from approximately 1,000,000,000 barrels in 1936 to nearly 1,750,000,000 barrels in 1946. In spite of the removal of this vast quantity of oil, the proved reserves have been greater at the end of each year than at the beginning, with the sole exception of 1943, when there was a relatively small amount of exploratory drilling because of the limitations upon steel for well-casings, imposed by the necessity of allotting large quantities of steel to ship-building and military equipment. It will be noted, however, that the curve entitled "Proved Reserves at End of Year" rises steeply for only four years, from 1936 through 1939, and thereafter shows a definite tendency to level off. There is little doubt that the peak of that curve will be recorded by 1950 and that thereafter it will descend toward zero.

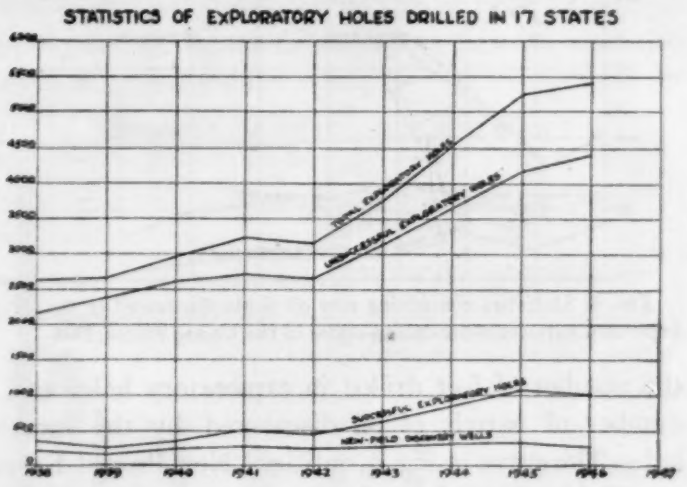


FIG. 4. Results of exploratory drilling in the 17 most important petroleum-producing states of the United States, 1938–46.

This somewhat gloomy forecast is borne out by a more detailed study of drilling operations in the 17 states that include the major part of America's petroleum resources. The essential data are depicted in Figs. 4, 5, and 6. The number of exploratory holes drilled in that area increased from 2,700 in 1938 to 5,400 in 1946, but the number of wells that discovered new fields fluctuated within very narrow limits and was only a little larger at the end of the selected period than at its beginning. Especially disappointing is the fact that there were fewer successful exploratory wells in 1946 than in 1945, although the total exploratory holes drilled in that year was appreciably greater. In spi e of the increased expenditure for exploratory drilling, the number of new fields discovered has decreased each year since 1943. Especially significant is the fact that the number of major fields (confidently estimated to contain over 10,000,000 barrels of oil each at the start of drilling operations) has decreased steadily since 1940. There is no doubt that in this area nearly all the large oil pools have now been located, and with rare exceptions only small pools containing only a few million

barrels await future discovery. Inasmuch as many of the more recent exploratory wells are deep tests, the more accurate presentation of results is expressed not by the simple number of holes drilled but by the relation between

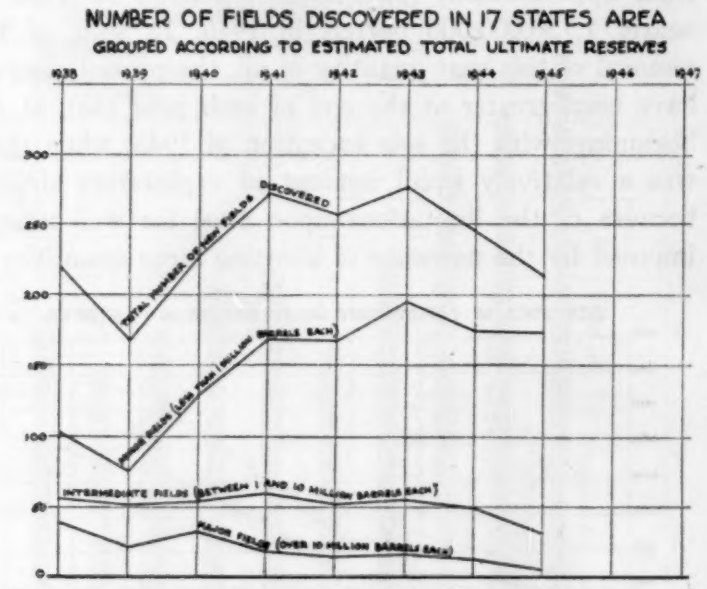


FIG. 5. Statistics concerning new oil fields discovered in the 17 most important petroleum-producing states of the United States, 1938–45.

the number of feet drilled in exploratory holes and the number of barrels of oil discovered by the successful holes. The curve in Fig. 6, entitled "New Proved Reserves per Exploratory Foot Drilled," tells the story with impressive solemnity. Its decline from 1938 to 1946, com-

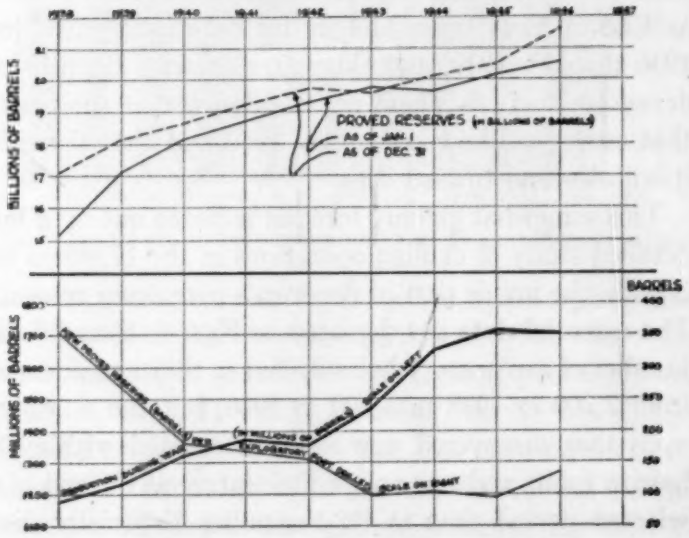


FIG. 6. Results of exploratory drilling for oil in the 17 most important petroleum-producing states of the United States, 1938–46.

pared to the increase in production from this 17-state area during the same years, is the crux of the problem and fully justifies the gloomy prediction with which the preceding paragraph was closed. This, of course, is the inevitable story for every oil-producing region in the world. Although for a time a locality or a nation may profit greatly from the rich stores of oil within its bounds, sooner or later those stores will be exhausted. We are dealing with a nonrenewable resource. We are burning up the capital provided by nature.

The United States is now enjoying the greatest petroleum production of all time. It is a safe expectation that the actual reserves of oil beneath its surface are two or three times the proved reserves of 20,000,000,000 barrels, but it is equally probable that its domestic production will fail to meet its needs within 5 or 10 years from now. Production will probably be maintained at levels far above 1,000,000,000 barrels per year for 25 or 30 years to come, but even such quantities will not be adequate to meet the steadily increasing demands.

Although we are prone to think of petroleum largely in terms of gasoline and diesel oil for internal combustion motors and of fuel oil for heating our homes and operating steam engines, the fact is that many other uses are now increasing the consumption of this most flexible of liquids. Not only are American farmers using power machinery to a larger extent as the years go by, but they are also using petroleum derivatives for insecticides and fungicides and many other purposes. Synthetic rubber based upon butadiene derived from petroleum, is a wartime development, but it is here to stay. At many an oil refinery the butadiene storage tanks bulk large against the maze of pipes and towers.

Faced by this prospect of increasing demands and dwindling supplies, petroleum geologists, engineers, and economists must employ every weapon in the arsenal of science and technology to meet the situation. Every barrel of oil brought to the surface must be used as effectively as possible. Much progress has been made in the last few years in the development of such refinery techniques as catalytic cracking, alkylation, and the fractionating of the lighter compounds in the mixture of hydrocarbons comprising every crude oil. Research continues to blaze the trail toward the most efficient use of natural resources, always an important aspect of the conservation.

At the same time, every effort must be made to insure the maximum production from the dwindling reserves. This involves two factors. First, there is the increase in percentage of recovery from pools, after they have been discovered, by improved methods of production, such as maintaining the optimum gas-oil ratio throughout the life of a well, and by using such methods of secondary recovery as the water drive and repressuring by gas injection. Second, there is the discovery of new pools either in new localities or by deeper drilling in old fields. This is the function primarily of the petroleum geologist and involves continuing research as well as the application of procedures already well established by long practice.

The importance of geology and geophysics is now well recognized throughout the entire industry in the United States, if not also in every other country. The statistics pertaining to the exploratory wells drilled in the United States in 1943 may be cited as illustrative of the reasons why geologists and geophysicists have established

ure place for themselves and may expect to continue ir activities in the search for petroleum for many rs to come. In that year 3,843 exploratory wells were lled. The location of 3,242 of these is known to have en selected on the basis of geological or geophysical rveys, or a combination of the two. Of these scientifily located wells, 626 proved to be productive—that approximately 20 per cent were successful. Of the mainder, 523 are known to have been located by nonchnical methods. Only 23 of these or less than 5 per nt, were successful. The method of determining the cation of the other 78 wells is unknown; 6 of them were oductive.

It is not to be expected, however, that this excellent cord of geological and geophysical achievement can be aintained in future years. Less favorable locations must e tested with the drill, if every oil pool, no matter how nall, is to be discovered. A smaller percentage of successl wells to total exploratory tests is inevitable as the arch becomes concentrated upon stratigraphic traps d the doubtfully effective structural traps.

Accepting the fact that almost all the large oil pools ithin the land area of the United States have by this me been discovered, attention at the moment is being ven to the possibilities of oil production from the subrged portion of the continent, known to geologists as e continental shelves. The Coastal Plain of Louisiana d Texas continues far out beneath the waters of the ulf of Mexico, and the present position of the shoreline s no relationship whatsoever to the occurrence of oil eneath its surface. From the standpoint of geology there s no reason to doubt the presence of salt domes beneath e marginal waters of the Gulf, quite similar to those eneath the adjacent shore.

Petroleum engineers have already had considerable perience with drilling operations in shallow water. Hundreds of wells have been drilled in Lake Maracaibo, enezuela, near its eastern shore. But off-shore drilling the Gulf of Mexico is a very different proposition om that in the quiet waters of Lake Maracaibo close to hore. Drilling platforms must be high enough above the ater to escape damage from storm waves, and out in e open waters of the Gulf where hurricanes occur almost very year, that means a height of at least 30 feet above igh-tide level. The engineering problems involved in onstructing stable bases for drilling operations are bviously very difficult.

Surveying techniques to determine favorable drilling ites depend largely upon the portable seismograph and e gravity meter. Adaptation of their use for underwater rveys has been greatly facilitated by certain of the genious devices developed for military purposes during e war. Similarly, radar has proved most satisfactory r precise location of points occupied by the surveyors—n extremely difficult operation when one is out of sight f land.

In spite of all the difficulties, two wells have already been completed off the Louisiana shore, one 5 miles, the other 30 miles, from land. The former, although drilled to a depth of 12,786 feet, failed to produce oil. The latter encountered the crest of a salt plug at a depth of 2,613 feet, thus verifying the interpretation of the geophysical survey, as a result of which the drilling site had been selected, but at last reports it, too, had failed to encounter commercial amounts of oil. Other wells are even now in various stages of preparation or drilling at distances of 10–40 miles from land. Similarly, among the Bahama Islands and elsewhere on the continental shelf bordering the south Atlantic states, surveys have been in progress for nearly two years, and drilling operations are scheduled to begin at an early date.

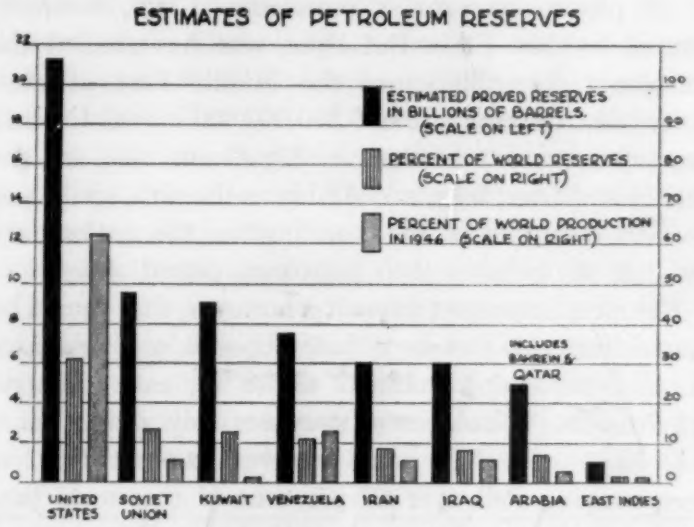


FIG. 7. Petroleum reserves and 1946 production of oil in 8 countries, each of which is believed to have possessed more than 1,000,000,000 barrels of proved reserves on January 1, 1947.

This extension of the search for oil to the continental shelf may confidently be expected to add a few billion barrels to American reserves, but at best it will postpone by only a few years the time when American production will lag far behind American consumption of petroleum products. It is therefore appropriate to look next at the prospects for meeting the future needs of America by importing oil from other countries.

As shown in Fig. 2, American interests control 75 per cent of the nearly 9,000,000,000 barrels of proved reserves in South America, more that 40 per cent of the 26,000,000,000 barrels of proved reserves in the Middle East, and nearly 30 per cent of the 1,400,000,000 barrels of proved reserves in the Far East. Thus, if political factors are favorable, the United States may draw upon nearly as many barrels of foreign oil reserves for its domestic needs as are presently available within its own boundaries.

But the United States does not exist in a geographical vacuum. It is but one among many nations having needs and rights with respect to petroleum. It is therefore imperative to consider this reserve from a world point of view. The broad features of the world picture are shown in Fig. 7, based upon the best estimates of proved

reserves made by competent geologists as of January 1, 1947. In all probability, such a graph portraying conditions 10 years hence would show a decrease in the proved reserves for the United States and an increase for every other country, with the possible exception of Venezuela, inasmuch as discovery and development have already advanced so much further in the States than elsewhere. One could almost venture the guess that, whereas the actual reserves beneath the United States are probably not much more than twice the amount shown as proved reserves, in the other countries they average at least three times the amounts shown for them.

Most amazing is the position of Kuwait, the tiny country at the head of the Persian Gulf, exceeded only by the United States and the Soviet Union in the volume of its proved reserves of petroleum. I am, however, assured by Mr. E. L. DeGolyer, who has studied the petroleum potentialities of the Middle East at close range, that the estimate of 9,000,000,000 barrels for that country is very conservative. Significant also are the positions of Iran, Iraq, and Arabia as the fifth, sixth, and seventh countries of the world, when the nations are listed in the order of their petroleum potentialities.

The most important inference, however, that should be drawn from this picture is based upon a comparison of the two percentage columns shown for each country. Whereas the United States possesses only a little more than 30 per cent of the world reserves, its production has been running well over 60 per cent of the world production each year. Venezuela is the only other country, possessing more than 1,000,000,000 barrels of proved reserves, in which the percentage of world production in 1946 exceeded the percentage of world reserves. The deduction is obvious: if present trends continue, 10–20 years from now the United States will be a "have-not nation" so far as petroleum is concerned; the "have nations" will be the Soviet Union, Kuwait, Iran, Iraq, Arabia, and the East Indies. It is no accident that practically all of the potential oil fields of the 5 last-named countries are under the control of American, British, and Dutch corporations.

This raises the question of the adequacy of the world's supply of oil for meeting the future world demands for petroleum products. At the moment, world consumption of petroleum is running at an annual rate of approximately 2,800,000,000 barrels. That is 4 per cent of the world's proved reserves and something like 1 per cent of the world's actual reserves. Demands are certain to increase greatly in the next few years, not so much as a result of increase in world population, but because of increased consumption by people who have not hitherto been large consumers of petroleum products. Whereas, for example, the annual peacetime consumption of petroleum within the United States is 450 gallons per capita, in the United Kingdom it is 80 gallons, in the Soviet Union, 50 gallons, and for the world as a whole, other than the United States, it is only 15 gallons p capita. This marked disparity is certain to be reduced the future by a great increase in the per capita consum tion of petroleum products outside the United States.

Even so, it would appear that world petroleum reserv are quite adequate to meet world needs for half or thre quarters of a century to come. But to use those reserv in the most efficient way, there must be almost comple freedom for distribution of the oil and its products fro the regions of supply to all parts of the world, regardle of political boundaries. Never was there more convincin evidence of the fact of mineral interdependence in th modern world, a fact that should be thoroughly com prehended by every person concerned with internation relations. In all probability, the optimum distributio of the abundant, but locally concentrated supplies o petroleum can best be attained by some sort of voluntar allotment or quota system, established and maintaine by agreements among the nations and corporation possessing and controlling the sources of supply and th means for discovery, extraction, and transportation o the oil.

There are, however, two reasons why alternativ sources of gasoline, diesel oil, fuel oil, and lubricants ar even now being sought. One is the fear that political an economic barriers may be raised against the free flow o oil from South America and the Middle East to th United States a few years hence, when American pro duction fails to meet American needs. A variant of tha fear is probably present in Great Britain, stemmin from the contemplation of British dependence upo foreign oil fields and the possibilities of a future war Despite the superb ingenuity responsible for the dis covery of the small oil fields in Nottinghamshire, there i absolutely no possibility of finding sufficient oil in th British Islands to meet more than a very small fractio of Britain's needs. The other reason is the fact that it i by no means too early to begin preparing for the inevi table day, which may come even before the end of th present century, when world production of oil will b inadequate for world needs.

Already, an appreciable fraction of American require ments for petroleum products is being met by the syn thesis of liquid hydrocarbons from natural gas. At th moment, a pilot plant for the synthesis of petroleum from oil shale is being completed and put into operation in Utah by the U.S. Bureau of Mines. Methods of syn thesizing petroleum products from coal, developed by German scientists before and during World War II, are being checked and improved in the research laboratories of governmental bureaus and private corporations in the States. The success of the oil-shale industry in Scotland and the great quantity of synthetic gasoline that helped so materially in providing power for the German war machines are sufficient guarantee that science and tech nology have provided an alternative source of supply,

long before the petroleum resources of the world have even begun to approach exhaustion.

These alternative sources are almost unbelievably abundant. In the United States alone, there is enough oil shale and coal available to provide the equivalent of 2,000,000,000 barrels of crude oil each year for at least 1,000 years. Similarly, if known techniques of producing petroleum products from coal by chemical synthesis were applied to the coal reserves of Great Britain, all British requirements for such products could be met for at least a few hundred years.

But such application of technical knowledge is not by any means an easy and simple matter. Processes now available are too expensive to permit competition with natural petroleum products except under extraordinary conditions, such as those that make the Scottish and Swedish oil-shale industries economically feasible. The necessary equipment is extremely complicated, very costly, and requires extensive plants. Its installation is not yet practical on a sufficiently large scale to permit such a substitution of mineral fuel sources in the immediate future.

Nevertheless, there is every reason to expect the gradual replacement of natural petroleum products by synthetic products in the more distant future. As the supplies of crude oil are exhausted, this alternative source will take their place. Thanks to science and technology, the mineral fuels stored within the earth will prove adequate for all human needs for as long a time as they are needed. Long before the oil-shale and coal are exhausted, still other sources of energy, such as the atomic energy released by nuclear fission, will be available to do the work that men want done.

Far more difficult than the technical problems involved in meeting the physical needs of humanity are the psychological and spiritual problems that retard the process of learning how to live properly in a world community. Perhaps knowledge of the fact that our small world is a world of potential abundance but inescapable interdependence, as illustrated by such an enquiry as this concerning one typical, nonrenewable resource, may help to accelerate that learning process.

Acknowledgements: I am deeply indebted to R. G. Watts of the Magnolia Petroleum Company, W. H. Wilson of the Humble Oil Refining Company, George Krieger of the Ethyl Corporation, and Roy Stryker of the Standard Oil Company of New Jersey for information and photographs used in the presentation of this paper as an illustrated lecture. The data pertaining to proved reserves of petroleum in countries other than the United States are based upon statistics published in the 1947 edition of the Petroleum Report prepared by DeGolyer and McNaughton. The record of drilling operations in the "17-state area" of the United States was compiled by F. H. Lahee and his Committee on Exploratory Drilling, of the American Association of Petroleum Geologists.

UNESCO Initiates Cooperation in the Abstracting of Biological and Medical Sciences

Eileen R. Cunningham
Vanderbilt University School of Medicine

A QUESTION OF INTEREST TO SCIENtists and physicians was the subject of a Conference on the Coordination of Abstracting Services for Medical and Biological Sciences, held by UNESCO in Paris, on October 3, 4, and 5.

The group of interested experts who gathered at UNESCO House were told by Dr. Julian Huxley, the director-general, in his address of welcome, that coordination in this important field was of importance in helping to remove barriers to the free dissemination of scientific ideas and information and, therefore, pertinent to international understanding. He also believed that coordination is important for the abstracting systems of all fields of knowledge.

Dr. Joseph Needham, director of the Natural Sciences Section, discussed some of its activities and stressed the importance of good abstract services for people working in remote parts of the world—for example, in China. Dr. I. M. Zhukova, medical counselor of the Natural Sciences Section, reviewed the events which finally culminated in the Conference. She pointed out that comments in the *British Medical Journal*, the report and recommendations of a committee of the Medical Library Association (USA) based on its recent study of the abstracting of medical literature, communications from the National Research Council (USA), and letters from Dr. John E. Flynn, editor of *Biological Abstracts*, had all served as an inspiration to call a discussion group together.

Dr. Hugh Clegg, editor of the *British Medical Journal*, was appointed chairman of the Conference, and Mrs. Eileen R. Cunningham, of the Vanderbilt University School of Medicine, president of the Medical Library Association, was named vice-chairman. Others present were Dr. Zygmunt Deutschman, director of Technical

Services of the World Health Organization; Prof. W. P. C. Zeeman, an editor of *Excerpta Medica*; Prof. Samson Wright, of the British Bureau of Abstracts; Dr. John E. Flynn, editor of *Biological Abstracts*; Dr. G. M. Findlay, editor of *Abstracts of World Medicine*; Mr. Edward J. Carter, of the UNESCO Libraries Section; other representatives of *Excerpta Medica*; and experts from the UNESCO Secretariat.

The major theme of the Conference was how to provide scientists and physicians with an adequate abstracting service at the lowest possible cost.

The National Research Council and the Medical Library Association were in agreement that amalgamation of existing nonprofit abstracting agencies on an international basis and the elimination of wasteful duplication were goals which were earnestly to be striven for. It was also obvious that this arrangement could probably not become effective immediately; therefore, at least for the present, abstracting will have to be done by existing agencies with some unavoidable duplication. The Conference discussed at length ways of effecting collaboration between the various services on an experimental basis to see what may be accomplished.

The Conference passed some important resolutions and recommendations, and its objective was stated clearly by the first resolution:

> It is desirable, on a cooperative basis, to provide a scientific medical information service by means of abstracting current publications at the lowest possible cost to the consumer.

Further discussion made it clear that, in order to be effective, this would have to be done on a nonprofit basis as far as is consistent with self-support. An interesting development was the statement by *Excerpta Medica*'s representatives that they would undertake investigation of methods of operation on a nonprofit basis.

Many of the terms used in connection with abstracting were thought to require clearer definition. Just what was meant by a "comprehensive" service came up for discussion, and it was decided that "a comprehensive abstracting service in the sense of abstracting all articles of all journals is impossible and undesirable," but comprehensiveness, in the sense that such a service would *survey* the whole of the world medical literature, would be imperative. Discussion brought out the fact that, of late, hardly a science exists in which some of the work reported does not occasionally have significance for clinical medicine. Collaboration with abstracting services in the nonmedical sciences was therefore considered of the utmost importance in order to obtain their aid in drawing the attention of the editors of clinical abstracting journals to such publications. It was also felt desirable that abstracting services intended for the practitioner as well as for the investigator should cover literature at a world level rather than, as they frequently do at present, cover literature chiefly at the national level or only work published in English.

The question of the content and scope of an abstra was discussed and it was concluded that:

> An abstract should give enough information to the read to enable him to decide whether he should consult the origin article abstracted and should include the principal data of th article. . . .

This is especially important for scientists working fa from large libraries who must depend to a great exten on film services for access to original articles. It was als thought desirable that an abstract should indicate if th work is of interest to several groups, e.g. physiologist chemists, clinicians, and should be as short and concis as is consistent with furnishing this information.

Duplication of specialists' abstracting journals wa regarded as undesirable.

Excerpta Medica was asked to consider discontinuing those special sections already covered in *Biological Ab stracts* and elsewhere. It was also recommended tha *Biological Abstracts* should consider revising its subject scope with a view to excluding material appropriately covered by other organizations, and it was suggested that *World Abstracts* (British) collaborate with *Excerpta Medica* in regard to the specialists' section.

It was suggested that UNESCO undertake to explore the existing need for various language editions of the comprehensive service and to promote the preparation and publication of comprehensive multilingual dictionaries in the biological and medical sciences.

While there were points of disagreement—for example, on the merit of "authors'" abstracts versus the "critical" abstract—the Conference felt that the value afforded by two days of free discussion was so great and so much progress had been made that a resolution was passed recommending and urging that an "Interim Coordination Committee on Medical and Biological Abstracting" be set up under the auspices of UNESCO, which would function as secretary and convener of the committee meetings.

In addition to representatives from the abstracting services which would be limited to nonprofit organizations, doing extensive abstracting international in scope, it was recommended that representatives from the World Health Organization, the International Federation of Documentation, the International Federation of Library Associations, and the Medical Library Association be included. It was stressed throughout that the needs of the consumer must be considered and that later the Committee could be enlarged if desired.

Because it was realized that this whole program has a bearing on the problem of the abstracting of the literature in other disciplines, it was decided to call the Committee "Interim," and in outlining plans, the possibility of later fitting them into a more extensive program would be carefully kept in mind. A Committee of Experts on Abstracting Services for the Natural Sciences as a whole

will probably meet during the coming year, and the possibility of a World Conference on Abstracting is also being considered by the Libraries Section of UNESCO. The Conference felt that work on coordinating the abstracting of biological and medical sciences should go forward without waiting for the larger conferences, and that any data obtained through this Committee would be useful to the contemplated conferences and should be made available so that the members could utilize that experience.

All delegates made it clear that they could not at this stage commit their organizations to definite action, but all will report on the recommendations made to see how far it will be possible to proceed, on an experimental basis, toward effective cooperation. Practical difficulties exist, and it will be important to see if they can be overcome. It was pointed out that, since abstracting services are being criticized for their wasteful duplication, every effort toward coordination should be made with a view to extending knowledge and not duplicating work.

World health is basic to world well-being, and the facilitation of the dissemination of ideas and information in the biological and medical sciences is vitally important to physicians and scientists who have the task of achieving it. UNESCO, working jointly and in cooperation with other organizations, can act as an important factor in breaking down the barriers which result from the isolation of ideas and information at the national level. The results achieved represented adjustments and willingness to cooperate evidenced by all participants. It is to be hoped that the Conference in Paris has laid the foundation for constructive thinking and progress in medical abstracting. The achievements which have been made will require continued interest and support.

Obituary

Hubert Lyman Clark
1870–1947

Hubert Lyman Clark, curator of Marine Invertebrates, emeritus, at the Museum of Comparative Zoölogy and associate professor of zoology, emeritus, of Harvard University, died in the Mount Auburn Hospital, Cambridge, Massachusetts, July 31, 1947, after a short illness.

Following early natural history studies dealing with butterflies, birds, and reptiles, he devoted the greater part of his life to the study of echinoderms and became one of the world's leading authorities on that group of animals.

He was born in Amherst, Massachusetts, January 9, 1870. His innate interest in natural history was stimulated by his father, William S. Clark, who was a student of the natural sciences, president of the Massachusetts Agricultural College, and founder of the Imperial College of Agriculture at Sapporo, Japan.

After publishing two papers on the butterflies of Amherst, the first when he was 13 years old, Hubert Lyman Clark turned his attention to birds and avidly continued these ornithological studies while at Amherst College, from which he was graduated in 1892. With the intention of making these studies his life work, he entered Johns Hopkins University as a graduate student in 1894. There, W. K. Brooks, whom Clark has characterized as "the greatest teacher I have ever known," quickly convinced the young ornithologist that there were other animals in the world besides birds. The interest in marine animals which Prof. Brooks imparted to his student was intensified during a field trip to Jamaica in 1896, when Clark saw for the first time the brilliant colors and varied forms of tropical sea stars, sea urchins, brittle stars, and sea cucumbers. This experience firmly established the study of echinoderms as his major pursuit from that time on.

During this trip to Jamaica he contracted yellow fever and was the only one of six victims of the disease to recover. Although this attack in no way impaired his general health, it did leave him with impaired hearing which made difficult the contact with people he so enjoyed. This affliction in no way affected his friendly disposition, however, or ever caused him to doubt that he was more than usually blessed with good fortune throughout his life.

After receiving his doctorate from Johns Hopkins in 1897, he spent two years at Amherst College as instructor in biology. In 1899 he was appointed professor at Olivet College and, in the same year, married Frances Lee Snell, who, although not a trained biologist, assisted him on many of his later collecting trips and made color sketches from life of many of his discoveries as a guide for the color plates which enhance his more important publications. In 1905 he accepted the invitation of Alexander Agassiz to join the staff of the Museum of Comparative Zoölogy. On only two subsequent occasions was he to return to the classroom, in 1929 as acting professor at Williams College and in 1936 as acting associate professor at Stanford University. After the death of Mr. Agassiz in 1910 he was appointed curator of Echinoderms and in 1927 curator of Marine Invertebrates and associate professor of biology. He held the latter position until he

reached the retirement age in 1935 and continued as curator until August 1946. Hubert Lyman Clark's entire background and character fitted him for the teaching profession, but when deafness interfered with this calling he loved so well, he became an excellent museum curator with one of the best-arranged and richest collections of echinoderms in the world to his credit. After his retirement as curator in 1946 he accepted an offer to work on the large collections at the Allan Hancock Foundation in Los Angeles and spent the winter and spring bringing his report on this material to completion. He enjoyed his usual good health during most of this period, and not until just before his departure for Cambridge and a well-earned rest at his summer home in New Hampshire was there any indication of his final illness.

His well-developed wanderlust and his belief in supplementing the study of preserved material with observations on living animals made him ever ready to journey to any region that promised good collecting. A lover of all sports, he considered collecting the greatest of them all. In addition to collecting extensively on both coasts of the United States, he visited Jamaica five times, Bermuda twice, Tobago, the west coasts of Central and South America, and the Galapagos Islands, Australia three times, and China and Japan. His trips to Australia in 1913, 1929, and 1932, during which he collected along most sections of the coast of that continent, furnished him with the material for his important studies on the echinoderm fauna of Australia.

His publications, in addition to the earliest ones on butterflies alluded to above, included more than 20 on the distribution, variation, anatomy, and pterylograph of birds. Even as late as 1945 he published a paper on th feather tracts of certain Australian birds and renewe his plea for greater recognition of this branch of orn thology. While he was at Olivet College he became inte ested in the reptiles and amphibians of Michigan an published six papers on these studies. More than 1 publications on echinoderms, many of them of a mon graphic nature, serve as his monument to individual r search in an era when an able scientist, unhampered b extensive administrative duties, could let his conscienc be his guide. These volumes cover material from most the outstanding museums and expeditions of the worl and reach a fitting climax in his monographs on th Australian fauna. In addition to these technical publica tions, several of a general biological nature and severa more covering his sociological and philosophical outloo have appeared.

In 1927 he was awarded an honorary degree of docto of science from Olivet College and in the spring of 194 a few weeks before his death, he received the Clark Memorial Medal for his service to Australian science.

ELISABETH DEICHMAN

Museum of Comparative Zoölogy, Cambridge, Massachusetts

FENNER A. CHACE, JR.

U. S. National Museum, Washington, D. C.

NEWS *and Notes*

This year, for the first time in its history, the Association has been able to print and mail its General Program to those who registered well in advance of its annual meeting. More than 1,500 copies of the Program of the Chicago Meeting a book of 340 pages listing more than 2,000 papers, were mailed from the Washington office during the first week in December. All applications accompanied by registration fees received after December 15 are being held and placed on file at the Information Booth in the Stevens Hotel, where they may be obtained for registering during the meeting.

A major problem in the preparing the General Program is to obtain complete copies of all the individual programs of the 67 sections and societies in time to permit editorial revision and printing at least three weeks in advance of the meeting. It is desirable that the programs be mailed early in December to avoid delays in handling mail that result from the heavy Christmas volume.

Advance distribution of the Program makes it possible for the registrant to plan the most economical use of his time during the convention. It is also a help to those who, until they have some knowledge of the papers to be presented, are uncertain whether they will attend the meeting. Moreover, early publication frees administrative personnel so that they may turn their attention to the many other local arrangements which must be completed during the two weeks immediately preceding the meeting. For example, the final weeks are critical in completing public-feature arrangements, particularly radio broadcasts based largely on selections from the General Program by specialty directors of national networks and local radio stations. Times for network programs are scheduled several month in advance, but the panels of speaker are often drawn up two weeks, or less, in advance of the meeting.

In order to ensure that the General Program shall be off the press according to schedule, it is necessary to set the deadlin for the receipt of program copy 4–6 week in advance of the publication date. If the secretaries are to meet the Association's deadline, they must undertake to organize their own programs several weeks earlier. Although the secretaries of most societies are able to meet the deadline, actual printing of the General Program is delayed until the last minute to obtain programs of late-reporting secretaries. Then commences a headlong rush to meet the publication date.

Early this year a general announcement was sent to the secretaries of the sections and societies, giving the schedule of deadlines to be followed in preparing

for the Chicago Meeting. The deadline for the receipt of copy for the General Program was set at October 21. On September 26 follow-up form letters were mailed, including examples of how the copy should be typed to conform with the standard format adopted for the Program.

The first manuscript copy for the General Program arrived a few days before the deadline, and the last program material accepted for publication was received on November 24. Every consideration was given to secretaries harassed by unavoidable delays. Only when it became apparent that the Program had to be completed in a matter of hours in order to have bound copies available for mail distribution on December 1 did the staff set aside last-minute requests for the inclusion of supplementary material. Corrections were made until the moment the presses began rolling. From October 21 through November 24, there was a constant exchange of manuscripts, galleys, corrected and recorrected proof.

Signatures of 16 or 32 pages are made up as soon as the galleys of type have been arranged into page form and numbered. It is, of course, impossible to assign page numbers to the various programs of the sections and societies until they have all been received and set in galleys. The last manuscript of the Chicago Program to be received belonged in the middle of the book and delayed the paging of all the remainder until after it was set in type.

The combination of printing separate signatures and making last-minute corrections sometimes leads to obvious inconsistencies. For example, last-minute corrections in the spelling of names on the programs may be caught in the Index, but cannot be change in the earlier printed signatures.

Publication of the General Program is an important part of the meeting arrangements, but it is by no means the most difficult. The problems of scheduling meeting rooms for 67 sections and societies, contracting for equipment and operators of projection apparatus, arranging and directing registration, entertainment, and publicity are equally formidable. The costs for providing these services run into many thousands of dollars. Those who attend the meetings of the Association are therefore urged to register, not only to obtain copies of the General Program, but to help meet the heavy expenses incurred to provide facilities for their benefit.

Members who do not attend the AAAS Meeting in Chicago may tune in on several radio programs scheduled during the convention period. On Friday evening, December 26, Harlow Shapley, president of the AAAS, will be interviewed on the well-known radio broadcast, "Meet the Press." The program is scheduled at 10:00 P.M. (E.S.T.) and may be heard over the network of the Mutual Broadcasting System.

A number of programs have been scheduled on Sunday, December 28. At 11:30 A.M., the Northwestern Reviewing Stand, carried by the Mutual Broadcasting System, will feature "Atomic Energy and Peace." K. Lark-Horovitz, general secretary of the AAAS, Philip Powers, adviser on scientific personnel, U. S. Atomic Energy Commission, and Walter Zinn, director of the Argonne National Laboratories, Chicago, will constitute the panel of speakers.

At 1:30 P.M. on Sunday, December 28, the National Broadcasting System will carry the Chicago Round Table of the Air. James B. Conant, president of Harvard University, George Stoddard, president of the University of Illinois, and Robert Redfield, Department of Anthropology, University of Chicago, will discuss "Prospects for the Scientific Study of Human Relations."

The Columbia Broadcasting System is preparing special AAAS coverage this year, not only of significant and interesting research reports but also of programs designed to place the social implications of science before the public. The following programs will be devoted to the meeting (E.S.T.): "Adventures in Science," Saturday, December 27, 4:30 through 4:45 P.M.—a news interview program conducted by Watson Davis of Science Service. "In My Opinion," Monday, December 29, 6:15 through 6:30 P.M.—a special CBS discussion series under the direction of George Crothers, of the Division of Education, Columbia Broadcasting System. "Frontiers of Science," Tuesday, December 30, 11:30 through 11:45 P.M.—general news, reports, and comments about the meeting. If circumstances permit, other 15-minute programs will be assigned daily at either 6:15 through 6:30 P.M. or 11:15 through 11:30 P.M.

One of the most interesting features of the broadcasts arranged by CBS will be a general coverage of society meetings and interviews with prominent scientists obtained by means of magnetic tape recordings, which will be edited and rebroadcast during the 15-minute intervals allotted by the network.

Other radio programs not mentioned here have been tentatively arranged. Undoubtedly, impromptu broadcasts, featuring special fields of science, will be made during the meeting under the auspices of the local broadcasting stations.

Organization of a new Society for the Social Study of Invention will be considered at the Chicago Meeting of the AAAS. As part of the program of Section K, a meeting will be held for this purpose in Room 105 of the Sherman Hotel on Tuesday morning, December 30. The proposed field for such a society would encompass the social effects of invention, the social causes and controls of invention, including the patent system fundamentally viewed, the psychology of invention, and the history of invention. Economists, sociologists, physical scientists, engineers, inventors, patent attorneys and officials, psychologists, and historians will all be interested in the formation of such a group. The Organizing Committee includes W. F. Ogburn, Department of Sociology, The University of Chicago, as chairman pro tem; Waldemar Kaempffert, science editor of the *New York Times*; Joseph Rossman, Washington, D. C.; Robert K. Merton, Columbia University; J. W. Oliver, University of Pittsburgh; and J. B. Gittler, Iowa State College. Watson Davis, of Science Service, Casper W. Ooms, recent Commissioner of Patents, and W. A. Hamor, of the Mellon Institute, will act as special advisers.

About People

Harlow Shapley, director, Harvard College Observatory, and president of the AAAS, has been elected an honorary foreign member of the Italian Academy of Lynxes. Since its founding in 1603 the Academy has been Italy's leading general scientific organization. **Ross G. Harrison,** Yale University, and **Arthur H. Compton,** Washington University, are the two other American members.

Theodore E. Boyd, Loyola University School of Medicine, Chicago, has been appointed to the newly created posi-

tion of associate director of research, National Foundation for Infantile Paralysis, New York. Dr. Boyd will collaborate with **Harry M. Weaver,** director of research, in coordinating the Foundation's program of study into the cause, control, and treatment of poliomyelitis and allied virus diseases. The Foundation has authorized $6,953,256.66 for such research since 1938.

Henry Augustus Pilsbry, curator of mollusks and other invertebrates, Academy of Natural Sciences, Philadelphia, was honored on his 85th birthday, December 8, at a meeting of the Academy. Dr. Pilsbry, who joined the Academy staff 60 years ago, is now completing an exhaustive monograph on "The Land Mollusca of North America."

Charles H. Brown, associate director, Iowa State College Library, and **Verner W. Clapp,** assistant Librarian of Congress, have left for Tokyo, at the invitation of Gen. MacArthur, to aid in setting up a National Diet Library similar to the Library of Congress. Dr. Brown will also visit China as a representative of the American Library Commission and chairman of the Association's Committee on the Orient and Southwest Pacific, which he has headed since 1942, to arrange for a series of library institutes in China during 1948.

Cecil J. Watson, professor of medicine, University of Minnesota, served as physician-in-chief pro tempore at the Peter Bent Brigham Hospital, Boston, from October 26 to November 1. While there, he delivered the E. Stanley Emery, Jr., Memorial Lecture on "Porphyria and Porphyrinuria: An Enlarging Concept of the Porphyrins in Clinical Medicine."

Titus C. Evans, Department of Radiology, College of Physicians and Surgeons, Columbia University, has been appointed research professor in radiology and radiobiology, and head, Laboratory of Experimental Radiations, College of Medicine, State University of Iowa. Dr. Evans will go to Iowa City on or about January 1.

Oscar F. Weber, a member of the College of Education faculty, University of Illinois, for more than 25 years, will soon retire because of ill health.

Lt. Col. Henry B. Webb of the Medical Administrative Corps, and former chief, Department of Bacteriology, Army Area Laboratory, Brooke Army Medical Center, Fort Sam Houston, Texas, is joining the faculty of the Department of Biological Sciences, San Antonio Junior College, in January, beginning with the second semester.

Ford M. Milam, former research assistant in soils and crops at North Carolina State College, was recently appointed coordinator of agricultural education and research under the American Military Government in South Korea, transferring from his previous position as adviser, Agricultural Experiment Stations, in that country. As coordinator, Mr. Milam, who was separated from the AAF in June 1946 as a major, will supervise and determine policy for all activities of the newly established agricultural extension system, the 13 central and branch agricultural experiment stations, and all agricultural schools and colleges in South Korea. The new extension service was originally proposed and outlined by Mr. Milam, who also acted as chairman for the drafting committee which prepared the plan for final approval and legal establishment by the South Korea Interim Legislature.

Visitors to U. S.

Paul L. Dengler, director, Austro-American Institute of Vienna, a director of the Austrian League for the United Nations, and a member of the Austrian Commission for UNESCO, lectured on "Educating World Citizens" at Ohio State University, December 10, under the auspices of the Ohio State Graduate School and the College of Education. Dr. Dengler is touring American colleges and universities under the sponsorship of the Institute for International Education in New York.

Sydney Goldstein, professor of mathematics, University of Manchester, England, and chairman, Aeronautical Research Council of Great Britain, who is currently (December 18–20) giving a series of four lectures at the University of Texas on "The Mathematics of Transonic and Supersonic Airflow," will give a series of eight lectures at the California Institute of Technology, in late December and early January. The series will be of a theoretical nature at an advanced level and will be concerned with recent developments in transonic and supersonic flow with some attention to compressible laminar boundary layers. Dr. Goldstein also delivered the Wright Brothers Lecture at the Institute of Aeronautical Sciences in Washington, D. C., December 17.

Subohd K. Mukherjee, Calcutta University, India, with a recent Ph.D. from Massachusetts Institute of Technology, is a member of the Seagram International Fellowship Program. He is currently engaged in research in Seagram's Louisville, Kentucky, laboratories.

Grants and Awards

The 1947 Nobel Prize awards were formally presented December 10 by King Gustav, at the Stockholm Concert House. Present at the ceremonies were **Carl F.** and **Gerty T. Cori,** St. Louis, Missouri, and **Bernardo Houssay,** Argentina, who shared the award in medicine; **Sir Edward Appleton,** England, winner of the physics award; and **Sir Robert Robinson,** England, chemistry prizeman. Three former prizewinners were also present: **Harold Urey,** 1934 winner in chemistry, and **Joseph Erlanger,** 1944 winner in medicine, both of the United States; and **Gerhard Domack,** German winner of the 1939 medicine award who, because of Nazi disapproval, was unable to accept it. Drs. Urey and Erlanger delivered their postponed Nobel lectures. King Gustav gave a dinner for the winners at the Royal Palace December 11.

Two annual awards for outstanding contributions to aviation medicine have been established by the Aero Medical Association of the United States. They are in memory of Raymond F. Longacre and Theodore C. Lyster, two of the first Flight Surgeons of the AAF, who contributed greatly to the early development of aviation medicine. The Longacre Award for 1947 has been presented to **Ross A. McFarland,** Harvard University, who was also made an Honorary Fellow of the Association, and this year's Lyster Award went to **Louis H. Bauer,** of Hempstead, Long Island.

Donald F. Jones, head, Genetics Department, Connecticut Agricultural Experiment Station, was honored by the Hybrid Seed Corn Division of the American Seed Trade Association at the Division's annual meeting in Chicago on

December 2. Dr. Jones received an award for his "outstanding contribution in suggesting the double cross method in seed production." It was in 1917 that Dr. Jones made the first "double cross" (recrossing two hybrids) at the Connecticut Station, a method which eliminated small, poorly matured hybrid seed, and seed which was too expensive for general use.

Norman W. McLeod, consultant to the Department of Transport in Canada, received this year's Highway Research Board award for an outstanding technical paper. The paper, "Airport Runway Evaluation in Canada," which was given at the Board's 1946 annual meeting, presents formulas to be used in designing airports and highways of the future to withstand extremely heavy loads.

The Sugar Research Foundation of New York has made a grant of $3,000 to the University of Texas Medical Branch, Galveston, for the support of research studies on protection of the liver bicarbohydrate from action of carcinogenic compounds, to be under the direction of W. A. Selle, director, Biophysics Laboratory.

The Fisher Award in Analytical Chemistry has recently been established by Chester G. Fisher, president, Fisher Scientific Company, Pittsburgh. This award of $1,000 and a medallion for outstanding achievement in analytical chemistry, which will be administered by the American Chemical Society, was founded to recognize and encourage important contributions to the science of pure or applied analytical chemistry made in the United States or Canada. Special consideration will be given to independence of thought and originality shown in a candidate's research, or to the significance of the work when applied to public welfare, economics, or the needs and desires of humanity. Nominees may be proposed by any member of the American Chemical Society. Nominations of candidates must be submitted by January 1 to Alden H. Emery, Executive Secretary, American Chemical Society, 1155 16th Street, N.W., Washington 6, D. C.

Mary E. Weeks, head of the translation service of the Kresge-Hooker Scientific Library, Wayne University, has recently been awarded an alumni citation from Ripon College for "outstanding ability and distinguished accomplishment in the field of chemistry." Dr. Weeks, who reads six languages besides English, is the author of *Discovery of the elements*, an associate editor of *Record of Chemical Progress*, official publication of the Library, and consulting editor of the new *Chymia*.

Fellowships

Radcliffe College has available for the year 1948–49 about 50 fellowships, with stipends ranging from $400 to $1,500, open to women candidates for the M. A. and Ph. D. degrees for advanced study under members of the Harvard faculty in the field of the candidate's choice. The larger awards are granted to those who have completed two or more years of graduate work, and preference in granting smaller awards is given to those who have completed one year of graduate work. Several tuition fellowships of $400 are, however, available to students who have done no graduate work, but who present evidence of high scholarship. Applications and a transcript of record should be submitted by March 1.

Colleges and Universities

The Chicago Professional Colleges, University of Illinois, have established a Department of Clinical Science to emphasize the interdependence of the basic sciences and the practice and progress of clinical medicine. The Department, to be headed by **A. C. Ivy,** vice-president of the University, will conduct research in normal and pathological gastrointestinal physiology, involving studies of enterogastrone in the treatment of peptic ulcer, cholecystokinin in the diagnosis of gall bladder disease, and the chemical structure of secretion; the biology of cancer, including studies of diagnostic tests for cancer, and growth-promoting and growth-inhibiting substances; the vital function of the kidneys; involving studies of prolongation of life after bilateral removal of the kidneys, and the mechanisms and most effective means of producing analgesia, involving a search for analgesic drugs and a study of where they act. Assistant professors assigned to the Department include **Morton I. Grossman, William H. Backrach, Louis R. Krasno,** and **L. L. Gershbein;** 5 research fellows and 30 graduate students are also conducting research in the Department. Three courses for graduate students are being offered this semester: Advanced Physiology of the Digestive System, Seminar in Clinical Science, and Research in Clinical Science. For undergraduate medical students there is a course on Physiology of Symptoms.

Applications for graduate assistantships at Oklahoma Baptist University for 1948–49 are now being received. The assistantships, paying between $900 and $1,000 for 9 months of part-time teaching, are open in geology, biology, chemistry, physics, mathematics, and engineering subjects. Students who qualify will be expected to carry graduate work at the University of Oklahoma, Norman. The stipend includes $900, paid to the student in 9 installments, plus out-of-state fees, if any, up to a maximum of $1,000. Other fees at Norman will be paid by the student. Regular transportation is available between the two campuses, 35 miles apart. Applications should be addressed to John W. Raley, president of OBU, Shawnee, and should be postmarked before March 1, 1948.

Elections

Camp Detrick, Frederick, Maryland, has organized a Sigma Xi Club, believed to be the first Sigma Xi Club organized at a governmental research installation. George B. Pegram, dean, Graduate School, Columbia University, and treasurer of the National Society of the Sigma Xi, was the installing officer and the principal speaker. Charter membership of the club consists of 54 members who are alumni of 38 local chapters in 21 states. It is expected that the club will sponsor lectures by outstanding speakers on subjects of broad scientific interest. Officers installed for the coming year are: L. A. Chambers, president; Berch Henry, president-elect; Emily Kelly, secretary; Archie Gorelick, treasurer; R. D. Housewright, Carl Brewer, and Charles Phillips, trustees.

Recent Deaths

Joseph Peter Connolly, 56, president, South Dakota School of Mines and Technology since 1935 and associated with that institution since 1919, died October 7 at his home in Rapid City, South Dakota, after a long illness.

George W. Pucher, 49, biochemist at the Connecticut Agricultural Experiment

Station, New Haven, died suddenly November 20 following a heart attack. During his 19-year association with the Station he had become known for his development of methods for determining various constituents in plants.

Claude Fountain, 68, physicist, Naval Research Laboratory, and former president, Tennessee Academy of Science, died November 28 after a short illness.

George E. Shambaugh, 78, chairman, Department of Otolaryngology, Rush Medical School, and head, Otolaryngology Department, Presbyterian Hospital, died November 30.

Edgar J. Witzemann, 63, professor of physiological chemistry, University of Wisconsin Medical School, died November 30 after a short illness.

Godfrey Harold Hardy, 70, emeritsu professor of pure mathematics, Cambridge University, died December 1 at Cambridge.

Raymond Harman-Ashley, 67, chairman, Department of Chemistry, St. Lawrence University, until his retirement in June, and inventor of the chemist's slide rule, died at his home December 1 after a short illness.

William Pepper, 73, dean emeritus, School of Medicine, University of Pennsylvania, died in University Hospital December 3, of a coronary thrombosis.

David L. Taylor, 31, assistant professor of botany, Department of Botany, University of Illinois, died December 6. Dr. Taylor joined the Illinois staff in September.

Make Plans for—

Northwest Scientific Association, December 26–27, Davenport Hotel, Spokane, Washington.

American Society for Professional Geographers, December 27–30, Charlottesville, Virginia.

Association of American Geographers, December 29–31, Charlottesville, Virginia.

Mineralogical Society of America, December 29–31, Ottawa, Canada.

COMMENTS
by Readers

We consider it our duty to offer the following information without delay, instead of waiting until we have accumulated enough data to write a detailed scientific report on our findings.

Surface tension measurements of solutions of sodium penicillin were carried out with the du Noüy tensiometer and the pendant drop technique. The results proved that solutions of sodium penicillin in distilled water are highly capillary active. The surface tension of a solution containing 10,000 units of penicillin sodium salt (Abbott)/cc. gave a surface tension of 31.7 dynes/cm.

Since the preparation, at least from a colloid-chemical point of view, must be considered to be composed of a hydrophilic cation and a hydrophobic complex anion comparable to soaps, it seemed only logical to assume that we are not dealing with true solutions, but hydrosols.

We therefore studied this preparation with a slit ultramicroscope. A highly colloidal system with particles ranging between approximately 100 and 500 mμ could be readily detected. The particles are anisometric, which is clearly evidenced by a very pronounced twinkling phenomenon. To make absolutely sure that this observation was not due to impurities contained in the commercial product used, we obtained, through the courtesy of Henry Welch, of the Federal Food and Drug Administration, a highly purified sodium salt of penicillin (F.D.A. Penicillin/Working Standard/Sodium Penicillin G/Potency 1,667 u/mg.), and dissolved it in triple-distilled water which, by itself, showed not the slightest indication of a Faraday-Tyndall cone. The solution, however, exhibited a very pronounced one, which clearly indicates that we are not dealing with a true solution, but with a colloidal sol.

Surface tension measurements of solutions of highly purified streptomycin calcium chloride complex of varying concentrations gave figures slightly above those obtained with distilled water at the same temperature. The preparation, if studied ultramicroscopically, however, shows very pronouncedly that it is a colloidal sol and not a true solution. The particle size of the dispersed phase averaged 65 mμ. That this sol is not capillary active might be due to the divalent calcium ion and its low degree of hydration. (ERNST A. HAUSER and RUTH G. PHILLIPS, *Massachusetts Institute of Technology,* and LT. (j.g.) JOHN W. PHILLIPS, MC USNR, *Naval Medical Research Institute, Bethesda, Maryland.*)

Lest some scientist needing a passport be discouraged by Dr. Bok's recent account of his unfortunate failure to obtain a passport within a limited time (*Science,* October 10, p. 341), may I describe a case in which the State Department acted with gratifying speed. One member of my recent Eclipse Expedition to Brazil mailed an application for a passport to Washington on March 25, and the passport was received by mail on April 3. No special telegrams were sent; no pressure was exerted by any government official. It seems to me that 9 days for a routine which normally requires three weeks represents excellent service. (CHARLES H. SMILEY, *Director, Ladd Observatory, Brown University.*)

The recent report of a study made by Davis and Briggs concerning the growth-promoting action of cellulose (*J. Nutrition,* 1947, **34,** 295) reveals a not uncommon type of error in the design of diets which makes the results of their use questionable. In this study, glucose in the basal diet was replaced by cellulose. If the cellulose served as a source of carbohydrate in the diet, such a substitution would be justified. However, even if the data on "crude fiber" were acceptable as an index of digestibility, they indicate that the cellulose served mainly as an inert material, especially

when more than 5 per cent was fed. The replacement of glucose by cellulose therefore reduced the carbohydrate content or increased the proportion of protein, fat, and other constituents of the utilizable part of the diet, and this may explain the results attributed to the cellulose.

A similar error, made by Guerrant and Dutcher (*J. Nutrition*, 1934, **8**, 397), led to the erroneous conclusion that cellulose had a vitamin B and G sparing effect. The replacement of sucrose by cellulose or agar in their basal diet reduced the carbohydrate content of the diet and hence also the vitamin requirements. Since then, Mannering, Orsini, and Elvehjem (*J. Nutrition*, 1944, **28**, 141) tested the effect of cellulose by adding it to their basal diet, and no vitamin sparing effect was found. It may be contended that the addition of purified cellulose to the diet requires an increase of minerals (Harriet Morgan. *J. Amer. med. Ass.*, 1934, **102**, 995), protein, and/or other constituents of the diet to maintain a balance, but the data on this subject are controversial (F. Hoelzel. *J. Amer. med. Ass.*, 1939, **113**, 351) and the greater error appears to be made by simply replacing utilizable nutrients by cellulose.

In short, cellulose should evidently be regarded as an inert or nonutilizable material unless there is evidence that it can be utilized by the species to which it is fed. A loss of "crude fiber" by the passage of cellulose through the digestive tract cannot be accepted as evidence of digestibility. This was indirectly indicated about 25 years ago when "Cellu Flour" was analyzed at the Connecticut Agricultural Experiment Station (Bull. 127, 1921, p. 230). A low "crude fiber" content was found, although this flour proved to be a satisfactory nonnutritive substitute for ordinary or starchy flour in the diabetic diet. The "digestion" of cellulose which is assumed to occur on the basis of "crude fiber" determinations may therefore mainly be a mere modification of the cellulose such as is produced in the manufacture of dietetic cellulose like "Cellu Flour." This modification is not produced by enzymes or bacteria.

It is not intended to imply by the foregoing that cellulose in the diet is of no value. On the contrary, its value for some species may be due chiefly to its relative inertness. In our longevity studies on rats (*J. Nutrition*, 1946, **31**, 363; 1947, **34**, 81), we used a basal or low-residue omnivorous diet and other diets consisting of the basal omnivorous diet and added cellulosic bulk-formers. The results obtained thus far indicate that suitable cellulosic bulk-formers tend to prolong the life span and can apparently do this without a stunting of growth (skeletal size, such as seems to have occurred in rats fed diets including ground No. 300 cellophane by McCay and his associates (*J. Nutrition*, 1934, **8**, 435). The details concerning our study will be reported elsewhere when the study is completed. A source of cellulose should evidently be included in the normal diet for man and other omnivores even if cellulose does not promote growth. (F. HOELZEL and A. J. CARLSON, *Department of Physiology, University of Chicago.*)

I wish to comment on "An Auditory Afterimage," by Rosenblith, Miller, Egan, Hirsh, and Thomas (*Science*, October 10, pp. 333–335).

If the curves in Fig. 1, A, are plotted to a log scale of time, they fall on straight lines that have simple equations of the form Duration = a + b log t, where a and b are constants that can be read from the chart. The equations are:

Lower curve, Duration = $-6 + 6\frac{1}{2}$ log t
Upper curve, " = $-9 + 9$ log t

The symmetry of these constants may be significant.

Attention is called also to an error in Fig. 1, B. The zero point on this log scale is at an infinite distance to the left of the point shown. The ordinate "0" should be 5. (DUFF A. ABRAMS, *801 2nd Avenue, New York City.*)

The recent article by Stephen S. Visher on "Starring in *American Men of Science*" (*Science*, October 17, pp. 359–361) seems constructive and desirable as far as it goes, but perhaps in one minor respect it should go a little further.

Apparently Dr. Visher contemplates a continuation of the policy of restricting the electorate to those previously starred, or to an additional number selected by some small committee who would add "competent experts" to the voting group. If we could rely on the assumptions (1) that substantially all the voters would vote fairly and impartially, (2) that substantially all the voters would take pains to see to it that newly added fields secured fair participation, (3) that substantially all the voters would give at least several hours careful consideration to the formulation of their votes, such a procedure might work fairly well. It is believed that assumption (1) is fully warranted, but that (2) is quite questionable and (3) even more so.

It is submitted that anyone of sufficient standing to be included in the volume at all should be sufficiently mature and well informed to be able to make a constructive contribution by voting, and therefore it is suggested that a democratic basis of selection be followed. A tentative outline of procedure might be as follows:

(1) Expand the fields to 5 or 10 times their present number with a brief, succinct definition of any field for which an adequately descriptive title is not found.

(2) Mail a ballot to each individual listed in the previous edition, and to each individual to be included in the forthcoming edition.

(3) Include with the ballot a list of the designated fields, and ask each recipient to designate the field in which he belongs.

(4) Request each voter to vote for a fixed number, say 10, whom he considers *most outstanding in the voter's field*, even though the recipient of the vote is active chiefly in some other fields, and regardless of whether or not the recipient is listed in the volume.

(5) Star as nearly as may be the same percentage in each field. Ten per cent seems a desirable figure.

The fact that newcomers to be listed for the first time in the forthcoming volume will not be known to voters, except by their activities and publications elsewhere, might be said to place a minor handicap on newcomers. To the extent that there is such a handicap, it is believed the handicap is desirable. It will tend to postpone, and perhaps prevent, the starring of the meteoric individual who happens to register some spectacular achievement, but whose record of achievement is not sustained over a period of years. (DONALD H. SWEET, 330 *South Wells Street, Chicago.*)

TECHNICAL PAPERS

Effect of the Injection of Glucose Into the Cerebrospinal Fluid

ROBERT W. LACKEY

Department of Physiology and Pharmacology, Southwestern Medical College, Dallas, Texas

The mechanism whereby the processes of carbohydrate metabolism are correlated with carbohydrate intake has been a subject of much investigation and discussion. One of the views which has received attention is that a control of insulin output of the islet tissue through the glucose content of the blood is an important factor. The evidence that a mechanism whereby increased amounts of glucose in the blood elicit increased insulin liberation involves the activation of centers within the brain stem is discussed by Macleod (*2*). In general, the experimental procedures which have been employed are of a laborious nature.

Recently, Marinelli and Giunti (*3*) have reported that injections of relatively small amounts of glucose into the cerebrospinal fluid by way of the cisterna magna result both in the dog and in man in a rapid and pronounced fall in glucose content of the blood, followed by a slower return to basal values. Marinelli and Giunti infer that the glucose content of the cerebrospinal fluid represents a direct chemical stimulation upon the glycoregulatory nervous centers, resulting in functional changes affecting the glucose level of the blood. They suggest that the blood-sugar curves look very much like those following insulin administration. If such responses consistently obtain following this procedure, which is easily carried out and which involves the introduction into the body of an amount of glucose so small as to be quantitatively insignificant in relation to the total glucose content of the body fluids, a number of experiments would be made practicable in further elucidation of the problem of regulation of blood-sugar levels.

In an attempt to corroborate the findings of Marinelli and Giunti, 6 normal, docile dogs were selected, and after a fast of 18 hours blood samples were taken. Without the use of an anesthetic, a needle was placed in the cisterna magna, 2 ml. of cerebrospinal fluid was withdrawn, and 2 ml. of a 5 per cent solution of glucose (Abbott's 5 per cent dextrose, pyrogen free) was injected. In each instance it was possible to carry out the procedure without signs of excitement on the part of the animal and without struggling. Blood samples for glucose determinations were taken at 5, 15, 30, 60, and 120 minutes after the glucose injection. Blood-sugar determinations were made in duplicate by the method of Hagedorn and Jensen (*1*). The results are shown in Table 1. It is observed that lowering of the glucose level of the blood was in no instance obtained following intracisternal injection of glucose solution. There appears to be a definite tendency toward an increase in glucose content of the blood during the second hour of the tests.

The experiment was repeated using 3 dogs anesthetized 15 minutes beforehand by the intravenous administration of pentobarbital sodium in a dosage of 30 mg./kg. of body weight. The results were essentially the same as with unanesthetized animals.

TABLE 1

BLOOD-SUGAR LEVELS FOLLOWING INTRACISTERNAL INJECTIONS OF GLUCOSE IN DOGS

(Blood sugar in mg./100 ml.)

Dog No.	Preinjection	Postinjection time in minutes				
		5	15	30	60	120
1	85	87	101	102	78	97
2	118	119	132	123	125	140
3	100	108	109	126	117	128
4	96	97	95	99	102	121
5	67	77	75	84	79	108
6	76	80	81	79	87	121

We are therefore unable to corroborate the findings of Marinelli and Giunti that the injection of small amounts of glucose into the cisterna magna results in a hypoglycemic reaction in dogs. Though the weight of glucose injected in our experiments was the same as that employed by Marinelli and Giunti, we may not have duplicated their procedure exactly, inasmuch as they make no statement as to the volume of solution in which the glucose was dissolved. The volume we used was chosen with a view to maintaining isotonicity.

References

1. HAGEDORN, H. C., and JENSEN, B. N. *Biochem. Z.*, 1923, **137**, 92.
2. MACLEOD, J. J. R. *Lancet*, 1930, **219**, 512.
3. MARINELLI, LUIGE, and GIUNTI, VALENTINO. *Proc. Soc. exp. Biol. Med.*, 1947, **65**, 23.

The Function of Ac-Globulin in Blood Clotting[1]

ARNOLD G. WARE, ROBERT C. MURPHY, and WALTER H. SEEGERS

Department of Physiology, Wayne University, Detroit, Michigan

It has been shown that a newly recognized plasma factor (*1, 2, 3, 5, 6*) accelerates the activation of purified prothrombin by thromboplastin. We refer to this factor as Ac-globulin (*6*). Because of its apparent importance we have concentrated our studies on its purification and its reactions.

Ac-globulin activity of plasma is quite different from that of serum. In serum the activity is comparatively more intense. Fig. 1 illustrates the difference. Curve A shows the activation rate with Ac-globulin of serum origin, and curve B, with Ac-globulin of plasma origin. In the former reaction the production of thrombin is far more rapid, but the final yield is the same as with Ac-globulin of plasma origin. For purposes of nomen-

[1] Aided by a grant from the U. S. Public Health Service.

clature we refer to these substances as plasma Ac-globulin and serum Ac-globulin. The properties of the two are so similar that no difference has been detected, even though both have been obtained in concentrated form.

Thrombin is the substance which is responsible for the production of serum Ac-globulin, and calcium ion is not required for that purpose. The most active thrombin prepara-

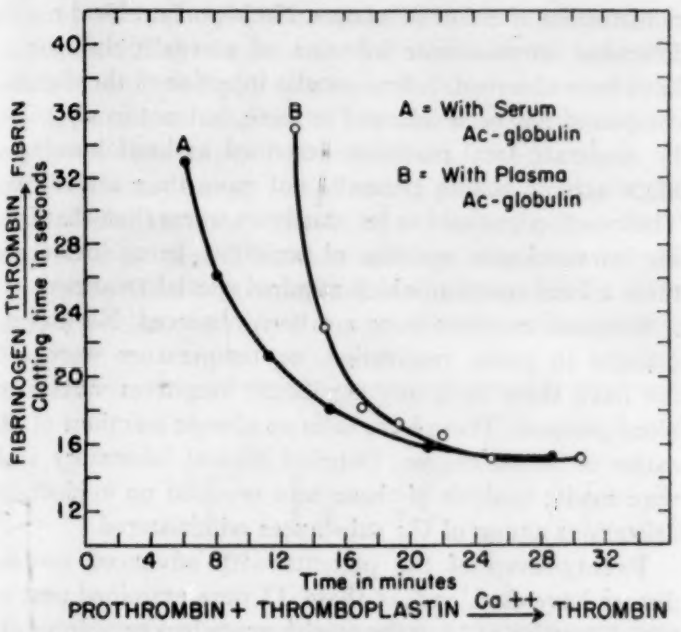


FIG. 1. Activation of purified prothrombin with serum Ac-globulin (curve A) and with plasma Ac-globulin (curve B) in the presence of excess thromboplastin and optimum calcium-ion concentration.

tions obtained to date have been added to large quantities of oxalated bovine plasma, and subsequently, concentrates of serum Ac-globulin have been obtained in quantity and quality equal to those obtained from bovine serum itself.

The function of Ac-globulin in the clotting mechanism can then be outlined by use of the following equations:

(1) Prothrombin + Thromboplastin $\xrightarrow{Ca^{++}}$ Thrombin

(2) Plasma Ac-globulin $\xrightarrow{\text{Thrombin}}$ Serum Ac-globulin

(3) Prothrombin + Thromboplastin $\xrightarrow[\text{Serum Ac-globulin}]{Ca^{++}}$ Thrombin

(4) Fibrinogen $\xrightarrow{\text{Thrombin}}$ Fibrin Clot

The clotting reaction is initiated by thromboplastin which comes from platelets and tissue juices. Some of the newly formed thrombin alters plasma Ac-globulin so that it becomes serum Ac-globulin. The latter intensifies the interaction of prothrombin and thromboplastin. Thrombin thus accelerates its own formation through an intermediate. This may be regarded as co-autocatalysis. These conclusions differ distinctly from those of Owren (*3*), but are in harmony with the old and well-known evidence presented in the literature to show that autocatalysis is involved in thrombin formation. This is, however, not autocatalysis but co-autocatalysis, because an intermediate is involved.

We have found that neither serum Ac-globulin nor plasma Ac-globulin can substitute for thromboplastin in the activation of prothrombin in the presence of optimum amounts of calcium ion.

The curves of Fig. 1 were obtained with the use of prothrombin prepared by $(NH_4)_2SO_4$ fractionation as described previously (*4*). This product possessed a maximum specific activity of 23,000 units/mg. of tyrosine. The activity was measured by the two-stage method (*7*). Plasma Ac-globulin was purified by the method briefly outlined (*5*). The same procedure was used for the preparation of serum Ac-globulin.

References

1. FANTL, P., and NANCE, M. *Nature, Lond.*, 1946, **158**, 708.
2. OWREN, P. A. *Lancet*, 1947, **252**, 446.
3. OWREN, P. A. *The coagulation of blood: investigations of a new clotting factor.* Oslo: J. Chr. Gundersen, Boktrykkeri, 1947.
4. SEEGERS, W. H., LOOMIS, E. C., and VANDENBELT, J. M. *Arch. Biochem.*, 1945, **6**, 85.
5. WARE, A. G., GUEST, M. M., and SEEGERS, W. H. *J. biol. Chem.*, 1947, **169**, 231.
6. WARE, A. G., GUEST, M. M., and SEEGERS, W. H. *Science*, 1947, **106**, 41.
7. WARNER, E. D., BRINKHOUS, K. M., and SMITH, H. P. *Amer. J. Physiol.*, 1936, **114**, 667.

The Action of Pteroylglutamic Conjugates on Man[1]

SIDNEY FARBER, ELLIOTT C. CUTLER, JAMES W. HAWKINS, J. HARTWELL HARRISON, E. CONVERSE PEIRCE, 2ND, and GILBERT G. LENZ

The Children's Hospital, Peter Bent Brigham Hospital, New England Deaconess Hospital, Boston, and *Departments of Pathology* and *Surgery, Harvard Medical School*

In 1944, Leuchtenberger, Lewisohn, Laszlo, and Leuchtenberger (*4*) reported that a "folic acid concentrate" and a fermentation *L. casei* factor inhibited the growth of sarcoma 180 transplanted in female Rockland mice. Further studies by Lewisohn and his co-workers (*5*) in 1945 showed complete regression in about one-third of the single spontaneous breast cancers observed in three different strains of mice treated with daily intravenous injections of 5 μg. of fermentation *L. casei* factor. This substance was thought at that time to be folic acid; it is now known that it was a conjugate of folic acid, pteroyltriglutamic acid (*3*). Subsequent work showed that pteroylglutamic acid (folic acid), when tested under similar conditions, was not effective in producing regression of these breast cancers (*6*).

In 1944, Hutchings, *et al.* (*3*) reported the isolation of the fermentation *L. casei* factor. This compound was shown to be 60–80 per cent as active when assayed with *L. casei* and 2–6 per cent as active when assayed with *Str. faecalis* R as was the previously isolated liver *L. casei* factor, pteroylglutamic acid (*8*).

Degradative reactions have shown that the fermentation *L. casei* factor differs from pteroylglutamic acid in that the

[1]We are grateful for the cooperation of Y. SubbaRow and his colleagues in the research division of the Lederle Laboratories Division, American Cyanamid Company, who are responsible for the chemical research which forms the foundation of these studies, and to Benjamin Carey, who made available these substances for experimental trial. The compounds were furnished in the form of dry material, yellow-orange in color, in sterile vials, under the names *teropterin* and *diopterin*.

Thanks are due to the staffs of The Children's Hospital, the Peter Bent Brigham Hospital, and to Shields Warren and the staff of the New England Deaconess Hospital, Boston, for invaluable assistance and cooperation which will be acknowledged specifically in detailed reports to be published. The assistance of Elisabeth Blumenthal, R.N., is gratefully acknowledged.

Supported in part by National Cancer Grant 250, U. S Public Health Service.

former compound contains two additional moles of glutamic acid (*1*). Consequently, pteroyl-γ-glutamyl-γ-glutamylglutamic acid (pteroyltriglutamic acid or *teropterin*) was synthesized and found to have microbiological activities identical with those of the naturally occurring fermentation *L. casei* factor (*2*). During the course of this synthetic work the compound pteroyl-α-glutamylglutamic acid (pteroyldiglutamic acid or *diopterin*) was also prepared and found to be only slightly active when assayed with *L. casei* and *Str. faecalis* R (*7*). This compound is not a naturally occurring substance. Its preparation indicated the possibility of further research with other members of the pteroylglutamic series.

The synthesis of these two compounds by SubbaRow and his co-workers made possible experimental clinical studies with new substances of the glutamic series of known chemical structure. Our decision to employ these compounds on patients with malignant disease was based on a critical analysis of the data in the cited reports of the animal experimental work by Lewisohn and his co-workers on the effect of the fermentation *L. casei* factor (now known to be pteroyltriglutamic acid).

It is the purpose of this note to report briefly some observations made in conjunction with the administration of these and closely related substances to 90 patients with malignant disease. Only those patients for whom established therapeutic procedures offered no hope of cure were selected for treatment with these compounds. This necessary restriction to patients with advanced neoplastic disease, most of them with metastases and many of them treated previously with X-radiation, makes difficult the interpretation of data and necessitates large numbers of observations. It is too soon to attempt any evaluation of the action of these substances on the course of neoplastic disease in man. This note will therefore be limited chiefly to a consideration of toxicity, dosage, method of administration, and certain general effects. Detailed clinical and pathological studies will be reported later.

This series includes patients with acute leukemia; astrocytoma; Ewing's tumor; carcinoma of the rectum, colon, stomach, cervix, prostate, pancreas, esophagus, bladder, breast, gall bladder, kidney, and ovary; Hodgkin's disease; lymphosarcoma; osteogenic sarcoma; ependymoma; spongioblastoma multiforme; seminoma; hypernephroma; leiomyosarcoma of the stomach; chondrosarcoma; epidermoid carcinoma of the pharynx and of the tongue; and embryoma of the kidney.

The patients varied considerably in age, 8 being under 3 years of age; 29 from 4 to 10; 4 from 11 to 20; 8 from 21 to 30; 10 from 31 to 50; 28 from 51 to 70; and 3 over 71.

The duration of treatment varied from a few days to 5 months; the average length of treatment was about 5 weeks.

After cautious initial trials were made, pteroyltriglutamic acid (*teropterin*) was administered in daily doses varying from 10 to 150 mg. intramuscularly and in other patients from 20 to 500 mg. intravenously. Pteroyldiglutamic acid (*diopterin*) was given in amounts from 50 to 250 mg. intramuscularly and from 20 to 300 mg./day orally. One patient received 19,000 mg. of pteroyltriglutamic acid over a period of 5 months, and 12,740 mg. were given intravenously to another in the space of 6 weeks, in both instances without evidence of toxicity.

On the basis of experience alone our present *initial* treatment calls for the administration of 20 mg. daily of either substance intramuscularly for one week, after which the dose is raised to 50 mg./day for two to three weeks longer. Decision concerning further experimental study is then made after the status has been evaluated.

Each substance was dissolved easily in from 1 to 8 cc. of saline for intramuscular or intravenous administration. When large amounts of the material were used intravenously, as large a volume as 20 cc. of normal saline was employed.

There have been no reactions following *intravenous* administration of either substance. No important local reactions following *intramuscular* injection of pteroyltriglutamic acid have been observed. Intramuscular injection of the diglutamic compound has been followed in some, but not in all, patients by moderate local reactions described as local burning and slight aching, lasting generally not more than several hours. This reaction was said to be usually no worse than that following intramuscular injection of penicillin. In no instance was there a local reaction which required special treatment.

Systemic reactions have not been observed. No important changes in pulse, respiration, or temperature were noted, nor have there been any significant long-term variations in blood pressure. There have been no allergic reactions of either major or minor degree. Detailed clinical laboratory studies were made; analysis of these data revealed no evidence of a deleterious action of the substances administered.

Twenty-seven of the patients with advanced neoplastic disease have died, and, of these, 13 were examined post mortem. Exclusive of 11 patients with acute leukemia from whom biopsies of bone marrow were obtained, there were 11 patients from whom biopsies of the tumor were obtained both before treatment was instituted and after treatment had been carried out for a period of at least a few weeks. Study of the gross and histological material available from these patients revealed no change in organs and tissues which could be regarded as a deleterious effect of the substances employed. In no instance was there any evidence of pancytopenia, agranulocytosis, degeneration of the kidneys, liver, or myocardium, or any suggestion of a polyarteritis.

The limited number and the short duration of these observations, and the possible role of psychotherapy, necessitate postponement of any conclusion concerning general effects upon the patient. In general, adult patients experienced improvement in energy, appetite, sense of well-being, and appeared to demonstrate less irritability and apprehension. In many instances, but not in all, such improvement might be ascribed to improved morale resulting from frequent visits, more medical attention to details of their complaints, and a definite impression that something more than usual was being done for them. In a few instances there was a definite diminution in pain which could be measured by a reduction in the amount of sedation or analgesia required.

Analysis of the collected data on the group as a whole showed that in a few instances conditions were such that a causal relationship was apparent between the administration of the glutamic compound employed and changes in the patient's condition or in the histological appearance of the tumor obtained at biopsy or at autopsy. In a larger group of patients with a clinical picture complicated by the use of more than one therapeutic agent (such as radiation therapy) in addition to the glutamic compound employed, changes were observed under conditions which suggested that it was the addition of the glutamic compound which played an

important part in their appearance. Examples of these changes were: temporary (several weeks) decrease in the size of multiple subcutaneous nodules of an amelanotic carcinoma; temporary (several weeks) decrease in size of metastases to the lung from a carcinoma of the testis; degeneration and necrosis which on two occasions was massive, as seen on pathological examination of tumors; reduction to normal on two occasions of several weeks each in the acid phosphatase level in the blood of a patient with multiple metastases to bone from a carcinoma of the prostate. Such changes have been by no means constant. They have occurred frequently enough, however, to warrant further experimental studies of the action of these and of related compounds on patients with cancer.

This preliminary report of the action of pteroyltriglutamic acid and pteroyldiglutamic acid on man reveals that these substances, as employed in these studies, are nontoxic and may be given either intravenously or intramuscularly. The absence of evidence of toxicity, as shown by clinical, laboratory, and post-mortem studies, and the ease of administration indicate that these substances are suitable for clinical use. No evidence has been presented in this report to suggest that these substances should be employed in the routine therapy of patients with cancer. Enough has been learned from these studies, however, to indicate that further investigation of the action of these and related compounds would be of interest.

References

1. Angier, R. B., *et al.* *Science*, 1946, **103**, 667.
2. Boothe, J. H., *et al.* *J. Amer. chem. Soc.*, in press.
3. Hutchings, B. L., Stokstad, E. L. R., Bohonos, N., and Sloane, N. H. *Science*, 1944, **99**, 371.
4. Leuchtenberger, C., Lewisohn, R., Laszlo, D., and Leuchtenberger, R. *Proc. Soc. exp. Biol. Med.*, 1944, **55**, 204.
5. Leuchtenberger, R., Leuchtenberger, C., Laszlo, D., and Lewisohn, R. *Science*, 1945, **101**, 46.
6. Lewisohn, R., Leuchtenberger, C., Leuchtenberger, R., and Keresztesy, J. *Science*, 1946, **104**, 436.
7. Mowat, J. H., *et al.* *J. Amer. chem. Soc.*, in press.
8. Stokstad, E. L. R. *J. biol. Chem.*, 1943, **149**, 573.

IN THE LABORATORY

A Mincing Apparatus for the Preparation of Embryo Extract for Tissue Culture[1]

Esther Carpenter

Smith College, Northampton, Massachusetts

In order to obtain more uniformity in the preparation of embryo extract, a number of substitutes have been suggested for the tedious method of cutting with scissors until pieces of tissue are too small to be identified. One of the simplest of these is the method suggested by Earle (*1*) in which a piece of monel metal screen of known mesh size is inserted in the base of a syringe, enough pressure then being exerted on the plunger to force the embryonic material through the mesh. This works satisfactorily with young embryos. If, however, one is using chick embryos of 10 or more days of incubation, two problems arise: (1) it is very difficult to exert enough hand pressure on the plunger to force the material through the screen; and (2) the increase in pressure is accompanied by danger of breakage of the syringe.

To circumvent these difficulties the equipment illustrated in Fig. 1 was devised and made of monel metal with the help of Russell Douglas, of the Physics Department. The tubular cup (A) is large enough to contain at least two 10-day chick embryos. At one end the cup is closed by a disc perforated by holes about 1 mm. in diameter. At the other end the inside of the cup is threaded to match the threads on the plunger (B). The latter is equipped with a horizontal handle by means of which the plunger can be screwed in far enough to force all the material in the tubular container through the holes in the base. For convenience, and also to avoid handling the equipment when sterile, a holder (C) was made which fitted around the cup and could be tightened by means of a screw in contact with a flattened area on the outside of the tubular container (A).

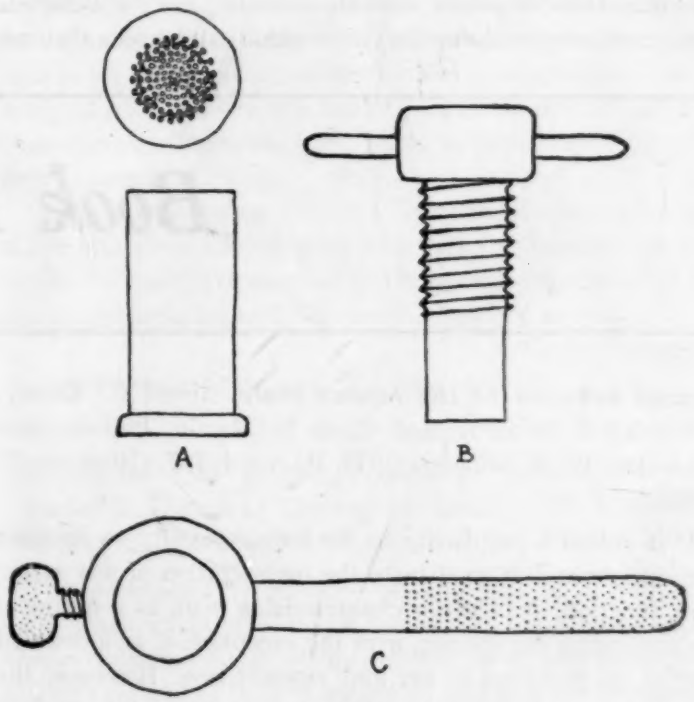


Fig. 1

This piece of equipment has proved very useful in our laboratory during the last few years. There is no danger of breakage, and the handle on the plunger and the screw arrangement make it possible to exert considerable pressure with a minimum of effort.

Reference

1. Earle, W. R. *Arch. exp. Zellforsch.*, 1933, **13**, 510–511.

[1] Contribution from the Department of Zoology, No. 216.

Use of an Electric Drill-operated Trephine in Preparing Turtles for Heart Beat Studies

JAY A. SMITH

Department of Physiology and Pharmacology, The Chicago Medical School, 710 S. Wolcott Avenue, Chicago

The turtle heart is excellent for many studies of the heart and its beat, both for teaching and research, because it has a strong beat, is relatively insensitive to manipulations, will beat for hours under average laboratory conditions, and requires only amphibian Ringer's solution as perfusate or as a washing solution.

The heart can be exposed only with some difficulty, since the tough shell must be cut or a portion removed. Formerly we cut the plastron from the carapace with a hack saw; this usually caused considerable hemorrhage, with resulting deterioration of the specimen.

We now use a trephine powered by a small electric hand drill. Our trephine cuts a hole $1\frac{3}{8}$ inch in diameter, but any trephine cutting a hole $1\frac{1}{4}$–2 inches in diameter will serve excellently. The handle of the trephine is removed, and the shaft is turned or ground down to a diameter of $\frac{1}{4}$ inch to fit into the chuck of the drill. The center spike of the trephine is adjusted so that it protrudes $\frac{1}{8}$ inch.

In use, the turtle is pithed and then held, back down, on a solid table. The spike of the trephine is placed a trifle cephalad to the center of the plastron. The drill is started, and run until the disc is cut from the plastron (Fig. 1). In a good preparation, the underlying muscles are not damaged in the slightest. The disc may then be pulled from the muscles, leaving a hemorrhage-free area overlying the heart which can be seen through the tissues, beating serenely. The dissection is completed by cutting through the muscles, avoiding large blood vessels. The heart may be used *in situ* or excised for perfusion experiments.

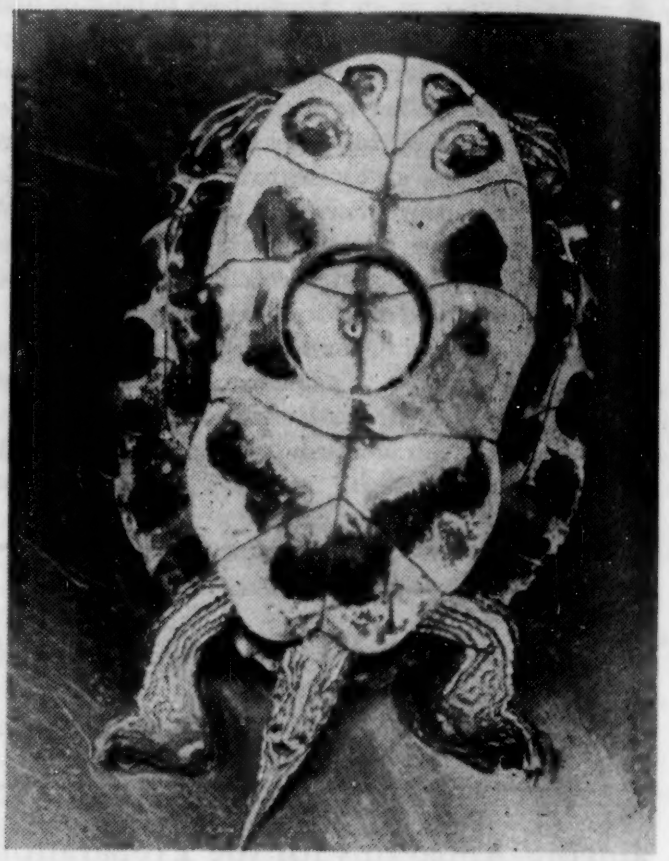


FIG. 1

This simple technic of cutting through the plastron with a trephine speeds the preparation of turtles for routine class use and prevents hemorrhage, insuring an excellent preparation.

Book Reviews

Sexual behavior in the human male. Alfred C. Kinsey, Wardell B. Pomeroy, and Clyde E. Martin. Philadelphia-London: W. B. Saunders, 1948. Pp. xv + 787. (Illustrated.) $6.50.

It is indeed a peculiarity in our human society to consider appropriate and in good taste the investigation of any structure, function, or behavior characterizing man, as a means of understanding our species, with the exception of well-directed studies on problems in sex and reproduction. However, the great advances in this field within the last 30 years have done much to provide a good foundation for further sound advances, and constructive fundamental researches on the multiple problems of sexuality are much needed.

The endorsement and support of this large research project, of which this volume is a partial report, by the Committee on Research in Problems of Sex of the National Research Council during the past 6 years; the excellent support rendered by the University of Indiana both in personnel and working facilities; the financial support and encouragement of the Rockefeller Foundation; and the preface by Dr. Alan Gregg, director of the Division of Medical Sciences of the Rockefeller Foundation, collectively assure the propriety, the merit, and the scientific soundness of the investigation. Whereas the facts revealed will shock many sensitive individuals who, like the majority, believe they know the pertinent facts of human sexual behavior because of their acquaintance with their own pattern which they consider 'normal,' the present volume will unfold an unbelievable variation among the members of the human population that must, of necessity, be comprehended before any degree of intelligence can be exercised by such counseling agencies as physicians, social workers, prison executives, institutional counseling personnel, or military authorities.

Representing some of the results from a study begun approximately 9 years ago by Prof. A. C. Kinsey, who is schooled in sampling techniques from his earlier investigations on variation among insect populations, this volume is the first in a series of 9 projected volumes in the investigation, which is scheduled for measurable completion within a period of 20

years. Dr. Kinsey has had the able cooperation of the two specially trained co-authors, who have developed the requisite technique and skill required to obtain the basic data, and also of an excellent staff of assistants; the statistical computations employed in the presentation of the materials have been enormous.

The research "is a fact-finding survey in which an attempt is being made to discover what people do sexually and what factors account for differences in sexual behavior among individuals, and among various segments of the population." It was approached in a commendable and necessary attitude of absolute unconcern with, or lack of any preconception of, what is rare or common, what is normal or abnormal, or what is morally or socially significant. The aim has been to accumulate facts and to attempt to understand the principal factors involved in a motivation of the different behaviors. The accumulated data are magnificently documented in 173 graphic illustrations and 151 tables, followed by a final chapter containing 48 pages of clinical tables with explanations for their use, and an appendix of 27 pages of tables and computations on sample size; a bibliography of more than 600 titles is included. To suggest but a very small number of the topics among those discussed, one finds data relating to early sexual growth, total sexual outlet, premarital, marital and extramarital intercourse, masturbation, nocturnal emissions, homosexuality, and the relations of age, social level, religious backgrounds, and other factors to the various facets of the general problem.

The procedures involved in the investigation are carried out by direct questions in a personal interview during which the sexual history is recorded in an essentially unbreakable code form; no written questionnaire has been employed. The strictest confidence has been maintained invariably, and the successful rapport established between interviewer and subject is nothing short of phenomenal, eliciting information which would in many instances be measurably condemnatory of the individual. The 12,000 histories already in hand come from every state in the Union, from individuals representing an age range of 5–90 years, and from all social levels—inmates of penal institutions, the underworld in general, laborers, clerks, farmers, business executives, grade schools, high schools, colleges and universities, and such professional levels as lawyers, physicians, clergymen, college professors, psychiatrists, and others. Adequate samples of histories from all social levels and geographical areas are included and will be further sought among the 100,000 histories estimated to be required to complete a final adequate assay of the total population. The present volume is based upon approximately 5,300 histories of white males. Succeeding volumes will include behavior studies in the human female comparable to the present volume on the male, sex factors in marital adjustment, legal aspects of the sexual problem, heterosexual-homosexual balance, and others.

A review of a book frequently carries criticisms of its shortcomings perhaps relative to an ideal. However, one is so thoroughly impressed with the courage demonstrated in the pursuit of this most difficult problem, with the extensiveness of the materials, with the adequate statistical treatments, with the openmindedness with which the entire project has been carried on, with the consummate artistry required to gain the basic information, and with the tenacity exhibited in the collection and presentation of the facts revealing such an unappreciated variation in human behavior, that criticism seems out of place. Some shortcomings and unfilled gaps do exist, but the authors themselves have pointed out many of them. The entire 800 pages are replete with data; what use will be made of these data remains for the acumen of the populace to demonstrate. The facts are now available, and in so effectively presenting them the authors are due the gratitude of all intelligent peoples interested in the advancement of knowledge.

CARL R. MOORE

The University of Chicago

Vector and tensor analysis. Louis Brand. New York: John Wiley; London: Chapman & Hall, 1947. Pp. xvi + 439. $5.50.

This book develops the algebra and calculus of vectors, motors, dyadics, tensors, and quaternions. There are extensive applications to geometry, including a chapter on the differential geometry of surfaces, to analytical mechanics, and to hydrodynamics. A tensorial treatment of electrodynamics, rotating electric machines, and relativity is reserved for a projected second volume. The range of subjects is so extensive that it is easier to point out a surprising omission, such as the representation of an arbitrary vector field in terms of its divergence and curl, than to detail the contents. The book emphasizes the main ideas rather than details of rigor; the treatment is clear, concise, and formal. A principle merit is the careful interrelation of the five disciplines presented. For example, covariant and contravariant components of vectors are introduced in the first chapter on vectors; base vectors are used throughout the chapter on tensors, and a tensor is defined as an invariant under arbitrary change of base vectors; homogeneous coordinates are introduced in the chapter on vector analysis and employed also in the development of motors; the development of vector analysis from quaternions and the alternate interpretation of three-term quaternions as real plane vectors or complex numbers is explained.

There are numerous excellent illustrations and applications set as problems. The reviewer feels that this book satisfies the needs of a serious student of mathematical physics in the five disciplines included and differential geometry as well.

C. A. TRUESDELL

Naval Ordnance Laboratory, Washington, D. C.

Differential and integral calculus: functions of one variable. Francis D. Murnaghan. Brooklyn, N. Y.: Remsen Press, 1947. Pp. x + 502. (Illustrated.)

This represents an attempt on the part of a front-rank mathematician to present the calculus as the mathematician always dreams it might be taught. The book fully justifies the author's statement that "the method used is radically different from that of the currently popular texts." The ϵ, δ process, nested sequences, the finite covering theorem, all the machinery which one usually associates with courses in advanced calculus, mathematical analysis, functions of a real variable are used throughout to build a genuine theory of the calculus. That the result is pretty formidable is fully realized by the author, who frequently admonishes the student to read hastily over the theory and start working the exercises. Of these there are over 1,200, many with hints for the student, for the author says experience has taught him that calculus can be

learned only by a judicious mixture of theory and practice. This does not mean that the theory is to be neglected or subordinated, for the student "must return as occasion permits and study over and over and thoroughly digest" the theoretical foundation on which the work stands. To do otherwise would be to miss the entire spirit of the book.

The book does excellently so many things the reviewer has long wanted to see done that he would like to recommend it unreservedly. If he cannot do so, it is because the author has aimed too high. The book will delight the mathematician; it will dismay the teacher of the calculus. For a second course it would be excellent, but for the beginner for whom it is intended it is too heavy a dose. There are rare occasions when the mathematician, against his will, is forced to yield to the professor of pedagogy; this, the reviewer feels, is one of them.

FRANCIS E. JOHNSTON

The George Washington University

Proceedings of the Society for Experimental Stress Analysis. (Vol. IV, No. 2.) C. Lipson and W. M. Murray. (Eds.) Cambridge, Mass.: Addison-Wesley Press, 1947. Pp. xxv + 121. (Illustrated.) $6.00.

This eighth volume of the series is a collection of 12 papers presented before the Society on subjects in the fields of static and dynamic testing of models and full-scale components, with emphasis on the electrical gaging methods and developments in the attendant circuit and telemetering techniques. All of the authors have been exceptionally careful in describing equipment and methods clearly.

Full-scale dynamic or fatigue testing is treated in six of the papers, "Fatigue Tests of Major Aircraft Structural Components," W. G. Pierpont; "A Method of Detecting Incipient Fatigue Failure," H. W. Foster; "A Machine for Fatigue Testing Full-Size Parts," A. F. Underwood and C. B. Griffin; "Some Repeated Load Investigations on Aircraft Components," S. A. Gordon; "Stress Analysis Utilization in Dynamic Testing," R. W. Brown; and "Device for Maintaining Continuous Electrical Connections With Reciprocating Engine Parts," W. A. Wallace and W. A. Casler. All of the above authors mention the inadequacy of static testing and of small model testing when the prototype is subjected to dynamic loads, and emphasize the desirability of full-scale dynamic tests.

Two of the papers, "Reluctance Gages for Telemetering Strain Data," by W. H. Pickering, and "Aircraft Instruments for Radio-Telemetering and Television-Telemetering," by C. L. Frederick, deal with problems and methods arising from the need for transmitting test data over some distance.

The remaining four papers are best described by their titles: "Precision Determination of Stress-Strain Curves in the Plastic Range," J. R. Low, Jr., and F. Garofalo; "Evaluation of Various Methods of Rotor-Blade Analysis by Means of a Structural Model," R. Mayne; "The Linear Variable Differential Transformer," H. Schaevitz; and "Design and Application of accelerometers," D. E. Weiss.

All 12 articles are worth careful study by workers in the field. The volume as a whole maintains the high quality record of the Experimental Stress Analysis series, with excellent editing and reproduction of illustrations.

D. K. WRIGHT, JR.

Case Institute of Technology

Scientific Book Register

BALLENGER, WILLIAM LINCOLN, and BALLENGER, HOWARD CHARLES. *Diseases of the nose, throat and ear.* (9th ed.) Philadelphia: Lea & Febiger, 1947. Pp. 993. (Illustrated.) $12.50.

BENTLEY, JOHN EDWARD. *General psychology: principles and practice.* Philadelphia–London–Montreal: J. B. Lippincott, 1947. Pp. xvi + 389. (Illustrated.) $3.50.

DAVIS, HALLOWELL. (Ed.) *Hearing and deafness: a guide for laymen.* New York–Toronto: Murray Hill, 1947. Pp. xv + 496. (Illustrated.) $5.00.

GOLDBERGER, EMANUEL. *Unipolar lead electrocardiography.* Philadelphia: Lea & Febiger, 1947. Pp. 182. (Illustrated.) $4.00.

HALDANE, J. B. S. *What is life?* New York: Boni and Gaer, 1947. Pp x + 241. $3.00.

HALL, JAMES D. *Industrial applications of infrared.* New York–London: McGraw-Hill, 1947. Pp. x + 201. (Illustrated.) $3.50.

HALL, JOHN S. (Ed.) *Radar aids to navigation.* (Massachusetts Institute of Technology, Radiation Laboratory Series.) New York–London: McGraw-Hill, 1947. Pp. xiii + 389. (Illustrated.) $5.00.

HARVARD UNIVERSITY COMMISSION REPORT. *The place of psychology in an ideal university.* Cambridge: Harvard Univ. Press, 1947. Pp. x + 42. $1.50.

MCDONALD, ELLICE. (Director.) *Neutron effects on animals.* Baltimore: Williams & Wilkins, 1947. Pp. vii + 198. (Illustrated.)

MATHEMATICAL TABLES PROJECT, NATIONAL BUREAU OF STANDARDS. *Tables of spherical Bessel functions.* (Vol. II.) New York: Columbia Univ. Press, 1947. Pp. xx + 328. $7.50.

SANBORN, COLIN CAMPBELL. *Catalogue of type specimens of mammals in Chicago Natural History Museum.* (Fieldiana: Zoology, Vol. 32, No. 4.) Chicago: Natural History Museum, 1947. Pp. 209–293. $1.00.

SAUL, LEON J. *Emotional maturity: the development and dynamics of personality.* Philadelphia–London–Montreal: J. B. Lippincott, 1947. Pp. xii + 338. $5.00.

SEELYE, ELWYN E. *Field practice: data book for civil engineers.* (Vol. III.) New York: John Wiley; London: Chapman & Hall, 1947. Pp. xiv + 306. (Illustrated.) $4.50.

SHRYOCK, RICHARD H. *American medical research, past and present.* (Studies of the New York Academy of Medicine Committee on Medicine and the Changing Order.) New York: Commonwealth Fund, 1947. Pp. xiv + 350. $2.50.

SPENCELEY, G. W. and R. M. *Smithsonian elliptic functions tables.* (Miscellaneous Collections, Vol. 109, Publ. 3863.) Washington, D. C.: Smithsonian Institution, 1947. Pp. iv + 366. $4.50.

WARTH, ALBIN H. *The chemistry and technology of waxes.* New York: Reinhold, 1947. Pp. viii + 519. (Illustrated.) $10.00.

WASIUTYNSKI, JEREMI. *Studies in hydrodynamics and structure of stars and planets.* (*Astrophysica Norvegica*, Vol. 4.) Oslo, Norway: A. W. Brøggers Boktrykkeri A/S, 1946. Pp. xvi + 497. (Illustrated.) Kr. 50,00.